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Master's Thesis in Veterinary Medicine

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Multiple correspondence analysis of questionnaire based biosecurity data on milk-fed dairy calves and associations with neonatal calf mortality

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Front page picture: Calf from a herd visited during this study.

Preface

This Master's Thesis was written as a final part of the master's degree in veterinary medicine at the University of Copenhagen. It was conducted at the Department of Veterinary and Animal Sciences, Section for Animal Welfare and Disease Control, and corresponds to 30 ECTS points.

The study was performed as a part of the "Robust Calves" project, a 4-year research project, which began in 2018 as a collaboration between the University of Copenhagen, Technical University of Denmark, Aarhus University and SEGES (under the Danish Agriculture & Food Council) and was funded by the Danish Cattle Levy Fund (Kvægafgiftsfonden) and the Danish Milk Levy Fond (Mælkeafgiftsfonden).

The work behind this thesis was carried out from September 2019 to February 2020, and a number of people deserve recognition for their help.

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Abstract

This masters' thesis was written as a part of the "Robust Calves" project, a collaboration between the University of Copenhagen, Technical University of Denmark, Aarhus University and the private farmer consultancy company, SEGES, under the Danish Agriculture & Food Council. To contribute to improving the knowledge about biosecurity in Danish dairy herds, our objective was to investigate the current application of biosecurity for milk-fed heifer calves in Danish dairy herds, explore possible patterns in management procedures, and compare this to the probability of neonatal calf mortality. This was done by analysing data from 'BioSecure' online questionnaires, regarding calf management and biosecurity procedures in the milk-fed calf sections, filled in by farmers as a part of the "Robust Calves" project.

Frequency analysis was carried out on 183 questions from 81 respondents and multiple correspondence analysis (MCA) was performed on 63 reduced questions from parts of the questionnaire, that were all answered by 69 respondents, to identify patterns in biosecurity and calf management. Herd size, number of properties, and whether animals had been bought were included as supplementary questions. Comparison of the probability of death for all calves within the first 14 days of life and the results from the MCA was performed with a multivariable logistic regression analysis.

The frequency analysis showed that the respondents answered that they perform several procedures to improve the level of biosecurity, for example that 100% of the respondents allocated colostrum for heifer calves, and 86.5% within 6 hours after birth. On the other hand, the level of biosecurity was lowered by for example only 12.3% of the respondents using single calving pens, and 19.8% always or sometimes allowing risk cows (e.g. cows testing positive for diseases) in the common calving area.

From the MCA, two dimensions, explaining 12.2% of the variance, were kept for interpretation. Dimension 1 was named: "*Preventive measures related to colostrum, and hygiene when handling milk-fed heifers*" and dimension 2: "*Herd size and dummy teat cleaning*". We found that management procedures considered as a higher level of biosecurity were positioned high on dimension 1, opposite from the procedures considered as lower biosecurity level. The questions included in the MCA did not divide respondents into groups with consistent implementation of procedures with a high or low level of

biosecurity. Herd size had a high dimension loading on dimension 2, with the mean position of large herds differing significantly from small and medium. This indicates a difference between management procedures in large herds compared to small and medium.

The multivariable logistic regression showed no significant effect of herd coordinates on dimension 2, suggesting that herd size and frequency of cleaning the dummy teat were not associated with the probability of neonatal death. A significant, negative correlation ($p<0.001$) was found between herd coordinates on dimension 1 and the probability of calves dying within 1-14 days of life. This means that herds using more procedures with a higher level of biosecurity had a lower probability of death for all calves within the first 14 days of life.

The findings in this study suggest that a more consistent implementation of biosecurity related management procedures could benefit the Danish dairy industry. It contributed to the existing knowledge on biosecurity in Danish dairy herds, and can hopefully be used as a tool to demonstrate the importance of biosecurity. A similar study with a larger sample size is advised, as the variance explained by the MCA in this study was not sufficient to provide solid evidence.

Resumé

Dette speciale blev skrevet som en del af projektet "Robuste Kalve", som er et samarbejde mellem Københavns Universitet, Danmarks Tekniske Universitet, Aarhus Universitet og SEGES. Formålet er at bidrage til den eksisterende viden om biosecurity i danske malkekvægsbesætninger, ved at undersøge den nuværende anvendelse af biosecurity for mælkefodrede kviekalve i danske malkekvægsbesætninger, identificere mulige mønstre i managementprocedurer og sammenligne dette med sandsynligheden for neonatal kalvedød. Dette gøres ved at analysere besvarelser på BioSecure online spørgeskemaet, som omhandler kalve management og biosecurity procedurer i afsnittet med mælkefordrede kalve, fra landmænd, som er en del af "Robuste Kalve" projektet.

Vi foretog frekvensanalyser på 183 spørgsmål fra 81 respondenter og udførte multiple correspondence analyse (MCA) på 63 reducerede spørgsmål fra sektioner af spørgeskemaet, som alle var besvaret af 69 respondenter, for at identificere mønstre i biosecurity og management af kalve. Besætningsstørrelse, antal ejendomme og hvorvidt der var blevet købt dyr ind blev inkluderet som supplerende spørgsmål. Sammenligning med sandsynligheden for kalvedød inden for de første 14 levedage og resultaterne fra MCA'en blev foretaget med en multivariabel logistisk regressionsanalyse.

Frekvensanalysen viste, at respondenter svarede at de udfører mange procedurer, som øger niveauet af biosecurity, eksempelvis at 100 % af respondenterne giver råmælk til kviekalvene, og 86,5 % inden for 6 timer efter kælvning. Omvendt sænkes niveauet ved at kun 12,3 % af respondenterne udelukkende bruger enkeltkælvningsbokse, og ved at 19,8 % altid eller nogle gange tillader risikokøer (f.eks. køer der er testet positiv for sygdomme) i fælleskælvningsområder.

To dimensioner, der forklarede 12,2 % af variansen tilsammen, blev valg til fortolkning fra MCA'en, nemlig dimension 1 som blev kaldt: "*Forebyggende tiltag relateret til råmælk, og hygiejne ved håndtering af mælkefodrede kvier*", og dimension 2 som blev kaldt: "*Besætningsstørrelse og rengøring af narresut*". Vi fandt at managementprocedurer der betragtes som værende af højere biosecurityniveau blev placeret højt på dimension 1, og modsat af procedurer med lavere biosecurityniveau. De inkluderede spørgsmål kunne ikke dele respondenterne ind i grupper med en gennemgående implementering af management procedurer med højt eller lavt niveau af biosecurity. Besætningsstørrelse

havde en høj loading på dimension 2, hvor den gennemsnitlige placering af store besætninger var signifikant forskellig fra små og mellem besætninger. Det peger på, at der er forskel på managementprocedurer i store besætninger sammenlignet med små og mellem.

Den multivariable logistiske regressionsanalyse viste ingen signifikant effekt af besætningernes koordinat på dimension 2, hvilket indikerer at besætningsstørrelse og frekvensen af rengøring af narresutter ikke er associeret med sandsynligheden for neonatal kalvedød. En signifikant, negativ sammenhæng ($p<0,001$) blev fundet mellem besætningernes koordinater på dimension 1 og sandsynligheden for at kalvene dør indenfor 1-14 levedage. Dette betyder, at besætninger med flere managementprocedurer der øger niveauet af biosecurity, har en lavere sandsynlighed for kalvedød.

Resultaterne fra dette speciale indikerer at en mere konsekvent implementering af managementprocedurer relateret til biosecurity kunne gavne den danske mælkeindustri. Specialet bidrager til den eksisterende viden om biosecurity i danske malkekvægsbesætninger og kan forhåbentligt blive brugt som et værktøj til at demonstrere vigtigheden af biosecurity. Et lignende studie med flere respondenter er anbefalelsesværdigt, da den forklarede varians fra MCA'en i dette studie ikke var nok til et tilstrækkelig evidensgrundlag.

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1. Introduction

Biosecurity, regarding production systems for animals, involves all measures done to prevent the spread of infectious diseases within and between animal populations. In husbandry, biosecurity is often separated into internal and external biosecurity. Internal biosecurity includes all measures to avoid the spread of infectious diseases within a population, whereas external biosecurity deals with all measures performed to avoid the spread of infectious diseases between populations (Dargatz et al., 2002).

In Canadian dairy farms, it has been shown that the level of biosecurity has a positive association with farm size where larger farms have a higher level of biosecurity than smaller farms (Denis-Robichaud et al., 2019). Renault et al., (2019) showed that a higher general biosecurity level in Belgian cattle farms resulted in a significantly lower mortality rate for calves aged 0-7 days, and an association between a higher level of biosecurity and a lower use of antibiotics in Belgian pig herds have been concluded (Laanen et al., 2013).

The Danish dairy industry has an overall aim to reduce the mortality rate of cows and calves, and to reduce the amount of antibiotics used for both cows and calves (SEGES, 2018). Biosecurity could play an important role in accomplishing these goals.

1.1 The importance of biosecurity

Infectious diseases can have severe economic consequences, depending on the infectious pathogen. Houe, (1999) described the economic consequences of bovine viral diarrhoea virus (BVDV) outbreaks, which affected both the individual farmer in terms of reduced production and increased mortality, and the society in terms of expenses for eradication and control programs. Implementation of strict internal and external biosecurity measures, and a test-and-cull strategy, were used to eradicate BVDV from Danish herds (Moennig and Becher, 2018).

An important factor in the economics of a dairy herd includes raising healthy, strong calves with a low mortality (Grønbæk et al., 2016). The most common infectious diseases reported as the cause of death or euthanasia for Danish dairy calves are diarrhoea and pneumonia (Grønbæk et al., 2016). The main pathogens involved in calf diarrhoea are E. coli, *Salmonella* spp., *Cryptosporidium parvum*, rota- and coronavirus and *Eimeria* spp. (Lorenz et al., 2011a). The listed bacteria can be isolated from animals without clinical

disease and are therefore not obligate pathogens, but cause disease when there is an imbalance between the calf's resistance and the infectious pressure (Lorenz et al., 2011a).

For pneumonia, some of the most common agents are bovine respiratory syncytial virus (BRSV), bovine parainfluenza type 3 (BPI3, bovine coronavirus (BoCoV), bovine rhinitis virus (IBR), bovine adenovirus, bovine herpes virus type 1 (BHV-1) and bovine virus diarrhoea virus BVDV. However, Denmark is considered free from BHV-1 and BVDV (Callan and Garry, 2002; DVFA, 2019; Moennig and Becher, 2018). Commonly isolated bacteria include *Trueperella pyogenes*, *Manheimia haemolytica*, *Histophilus somnus* and *Pasteurella multocida* and also *Mycoplasma* spp. can be isolated, but calf pneumonia is considered a multifactorial disease complex. The bacteria listed can also be isolated from the upper respiratory tract of healthy calves. In most cases, viral agents will predispose for secondary bacterial infections, causing a more severe pneumonia, yet, animal stress, inadequate levels of immunoglobulin G (IgG) and not vaccinating are also risk factors in developing pneumonia (Callan and Garry, 2002).

In summary the prevention of diarrhoea and pneumonia is complex but includes good management procedures with a high level of biosecurity, to ensure a population of immunocompetent calves and a low infectious pressure in the environment.

The most important part of ensuring immunocompetent calves is the allocation of colostrum. When a calf is born, it is born without IgG and is therefore dependent on the absorption of maternal IgG from the colostrum. Colostrum management and allocation is an important part of internal biosecurity, since it plays a major role in protecting the calves from diseases (Godden, 2008).

To lower the infectious pressure from the environment, correct cleaning and disinfection of utensils and inventory is necessary. To effectively lower the number of colony-forming units (cfu)/m^2, it is important to both clean correctly, and to dry and disinfect. Correct and effective cleaning involves cleaning with warm water rather than cold water, drying out the surfaces and afterwards disinfecting with the correct concentration of disinfectants (Böhm, 1998). These recommendations will ensure an overall high level of hygiene, because they are focused on lowering numbers of bacteria present in the environment. The same procedures (cleaning, drying, disinfecting) will effectively lower the number of

Cryptosporidium spp. and *Eimeria* spp. in the environment, given the correct disinfectants are used (O'Brien, 2012; Thomson et al., 2017).

Besides preventing the spread of disease between animal populations, external biosecurity also encompasses the zoonotic aspect of disease. An example of this is human salmonellosis, which raises a public health problem by being one of the main causes of gastrointestinal infections worldwide. Numerous *Salmonella* serovars, which can cause gastrointestinal infections in humans, have their primary reservoir in livestock populations, and are typically transmitted to humans by contact with *Salmonella* infected animal products (Rabsch et al., 2013). A Danish control programme has successfully lowered the number of herds testing positive for *Salmonella enterica* subsp. *enterica* serovar Dublin (S. Dublin) (SEGES, 2020a). After eradicating a specific pathogen from the herd, external biosecurity is extremely important in preventing a reintroduction (Vaessen et al., 1998).

To summarise, biosecurity is important for economics, to improve animal resistance, lower infectious pressure and ensure public health. Ways of measuring biosecurity, both in terms of different levels of biosecurity and farmers' attitudes towards biosecurity, will be briefly introduced.

1.2 Measuring aspects of biosecurity

Questionnaires regarding biosecurity have been used in several studies to quantify different aspects of biosecurity in cattle production.

In the study of Laanen et al., (2014), a questionnaire was used to investigate Belgian pig, cattle and poultry farmers' perspective on biosecurity, and to compare these perspectives with each other. The participants were asked to define biosecurity and afterwards asked questions of their perception on whether biosecurity was important to prevent the spread of disease. The study found that farmers who were able to correctly define biosecurity had a more positive belief in the effects of implementing biosecurity measures.

Besides analysing biosecurity from the farmers' perspective, a questionnaire was also used to compare various practices, opinions and communication of biosecurity across veterinary practitioners and dairy advisors, to be able to improve the implementation of biosecurity at dairy cattle farms. They found a need for a standardization of information between

veterinary practitioners and dairy advisors (Sayers et al., 2014). Furthermore, a questionnaire has also been used to help farmers and veterinary advisors to identify transmission routes for S. Dublin in Danish cattle farms, by the development of a scoring system for risk assessment (Nielsen and Nielsen, 2012).

In summary, questionnaires and their corresponding answers can be used to investigate perceptions and levels of biosecurity in research but can also be used as an advisory tool for veterinarians, other herd health advisors, or as self-assessment for the farmer.

Questionnaires for quantifying the level of biosecurity in cattle farms have been used in both Finland (Sahlström et al., 2014), Belgium (Sarrazin et al., 2014), USA (Negrón et al., 2011) and Canada (Denis-Robichaud et al., 2019) to study the implementation of biosecurity measures at cattle farms. All of these studies found that there was a potential for improvement regarding the level of biosecurity. Since the intensity of livestock production and occurrence of diseases varies between countries, the level of and need for biosecurity also varies. Therefore, it is important to evaluate the current biosecurity measures in every country in order to find out which measures could be improved (Nöremark et al., 2010). A study using a questionnaire to investigate the effect of management procedures on the successful control of S. Dublin in Danish dairy herds was carried out in 2008-2009. The questionnaire used was developed based on factors proposed to constitute a risk for Salmonella infections (Nielsen et al., 2012). To the authors' knowledge, no study aiming to assess the overall level of biosecurity in Danish dairy herds has been carried out.

1.3 Aim and objective

The aim of this study was to contribute to improveing knowledge about biosecurity in Danish dairy herds. This knowledge may be used to raise awareness and thereby improve calf related biosecurity and hopefully improve the overall health in dairy herds.

The objective of the study is to investigate the current application of biosecurity for milk-fed heifer calves in Danish dairy herds, explore possible patterns in management procedures, and compare this to the probability of neonatal death by analysing answers from the online BioSecure questionnaire completed by dairy farmers taking part in the "Robust Calves" project.

Our plan was to do this by 1) analysing the frequency of the responses to the questionnaire, 2) performing a multiple correspondence analysis (MCA) on the responses, and 3) investigating the association between results from the MCA and the probability of death for neonatal calves using multivariable logistic regression analysis.

2. Material and method

2.1 Selection of respondents

The recruitment of farmers for the "Robust Calves" project was based on a list of veal calf producers created by two veal calf advisors from the private farmer consultancy company, SEGES, under the Danish Agriculture & Food Council. The herds on the list were included based on their large size and the fact that they used regular dairy herds as suppliers of calves. To represent the whole country, herds were contacted based on their geographical location. Seventeen veal calf producers were included in the project. For each veal calf producer included, the dairy herds supplying calves to these were contacted and asked to join the project. The dairy herds were contacted, starting with the largest supplier, until five supplying dairy herds for each veal calf producer were included. In two cases, four supplying dairy herds were accepted. In total 83 dairy herds were included in the project. Each of the dairy herds was visited, and a representative of the dairy farm answered an online questionnaire in Danish (BioSecure) regarding milk fed calves in dairy herds. Hence, the data collection for our study was performed by "Robust Calves"-project workers, and took place between September 2018 and November 2019. In eight herds, we participated in the data collection in September and October 2019, along with representatives of the "Robust Calves" project.

2.2 Herd and calf mortality data

As part of inclusion in the "Robust Calves" project, the farmers signed a cooperation agreement, in which they gave permission to extract herd specific data from the Danish Cattle Database. All events of death and euthanasia of live born calves within the 12 months prior to answering the questionnaire were extracted and divided into two groups: alive at day 14, and dead or euthanized before day 14.

2.3 BioSecure questionnaire

Two BioSecure questionnaires were developed by researchers from the University of Copenhagen, Faculty of Health and Medical Sciences, Department of Veterinary and

Animal Sciences in collaboration with the Danish Technological Institute, SEGES and the counseling company SAGRO (BioSecure®, Nielsen et al., 2017). One questionnaire concerned biosecurity in veal calf herds and one concerned biosecurity in the section of milk-fed calves in dairy herds. Only the latter was used in our thesis and will therefore be referred to as the BioSecure questionnaire. The BioSecure questionnaire was developed in Danish but translated to English for this thesis.

Before answering the questionnaire, the respondents were asked questions regarding their herd. The questions included their role on the farm, the number of cows, animals, heifers and calves at the time of responding, number of properties, number of animals bought within the last year and the number of herds animals have been bought from.
The BioSecure questionnaire contains 13 sections, each section concerning a specific area of calf management (table 1). The questions and answers have been tested by farmers and revised according to feedback. The questionnaire consists of 183 questions with between 2 and 14 possible answers to each. Most answers in the questionnaire have been given a score according to current evidence-based knowledge and expert assessments. After completing the questionnaire, two reports with scores for each section and an overall score of calf-related biosecurity is produced by the system and presented to the farmer as printable pdf-files.

Farmers responded online in Danish. In some cases, a representative from the "Robust Calves" project was present in the room, to provide technical assistance if needed, while the questionnaire was answered, and in other cases the farmers were alone while answering. There were no restrictions as to who was allowed to respond, but it was encouraged that the person responsible for the caretaking of the calves, or someone with an overview of the caretaking routines, responded. For some herds the questionnaire was filled in by a collaboration of employees. The frequency analysis was performed on all 183 questions using R version 3.5.3 (R Core Team, 2019).

2.3.1 Reduction of the questionnaire

Some sections were answered exclusively by respondents with certain management procedures, meaning only the sections relevant to them were responded to. Furthermore, some questions within a section are "paths" on which the farmer is lead based on previous answers. This means that not all questions were answered by all respondents. To accommodate the missing answers in certain questions for some respondents, a reduction

of questions within paths was performed, so that all questions included in the multiple correspondence analysis (MCA) were answered by all respondents.

Table 1: *Overview of the 13 sections of the BioSecure questionnaire*

No.	Title	Number of questions	Number of paths
1	General biosecurity among milk fed heifer calves	12	2
2	Calving and the new-born calf	16	2
3	Allocation of colostrum	15	3
4	Quality of colostrum	9	0
5	Milking and storage of colostrum	14	3
6	Whole milk and milk replacer for heifer calves	17	2
7	Waste milk for heifer calves	18	2
8	Allocation of milk and feed for heifer calves	12	2
9	Contact between calves – single housing	7	0
10	Cleaning among calves – single housing	16	0
11	Contact between milk fed calves – group housing	13	0
12	Cleaning among calves – group housing	16	0
13	Bull calves	18	0

The answers were created to accommodate most management procedures, so that farmers should be able to find an answer that fits their current procedure(s). However, some answers are very alike in terms of biosecurity level, and through our reduction of answers within each question, these similar answers were combined. Answers both chosen by few individuals, and with similarity in terms of biosecurity were merged. Some questions are matrix multi choice questions, which involves several subquestions in each question with more than one possible answer. These were not included because it would be a time-consuming process to reduce them and was only relevant for few questions. The merging of answers was based on scientific papers, the frequency analysis and general knowledge about calf health and disease prevention.

The reduction of data and multivariable logistic regression was performed using R version 3.5.3 (R Core Team, 2019) and the visualization of the predicted results was performed using the ggplot2 package (Wickham, 2016). MCA and visualization of the results was performed using the FactoMineR and factoextra packages (Kassambara and Mundt, 2017; Lê et al., 2008).

A thorough description of the reduction of answers and paths is presented in section 2.3.1.1 in examples for section 5 of the questionnaire regarding milking and storage of colostrum. A similar approach was used for the reduction of all sections included in the MCA. The entire questionnaire and the full reduction of questions with arguments and references can be found in appendix 1.

Section 5 has 14 questions, some of which are matrixes that contain more than one sub-question, and some are questions within paths. The questions have between two and six possible answers.

2.3.1.1 Reduction of answers

The first example is the reduction of the question "*Is the colostrum stored in an open container for a period of time after milking (for example, in open buckets in the milking pit, milking room or by robot)?"* which has three possible answers: "*Yes"*, "*No"* and "*Sometimes"*. In the frequency analysis (appendix 1, question 59), it was observed that all answers have been used. Following this, the answers were analyzed in terms of their meaning. In this particular case "*Sometimes"* can be perceived as once a month for one farmer, and twice a week for another, but regardless of perception, the answer constitutes that the procedure happens. Therefore, the answers "*Yes"* and "*Sometimes"* were merged into one new answer renamed "*Yes"*. Merging of answers of the same character have been performed throughout the reduced sections, under the assumption that if a certain procedure happens sometimes, it constitutes a risk in the same way it does if the procedure is always done.

2.3.1.2 Reduction of paths

Question 54 divides the farmers into two paths, concerning whether they clean the milking kit used for milking colostrum automatically or manually. If they answer "*Automatically*", the path contains one question regarding the frequency of cleaning (appendix 1, question 55), and if they answer "*Manually*" the path contains one questions with three sub-questions about cleaning procedures with six possible answers of frequencies (appendix 1, questions 56.1, 56.2 and 56.3).

For the question regarding automatic cleaning of the milking kit, the frequencies were grouped into "*between every cow or more frequent*" and "*after each milking or rarer*" based on the frequencies. "*Between every cow or more frequent*" included "*Smaller cleaning between each cow, 1-2 larger cleanings daily*" and "*Before/after every cow*", while "*after each milking or rarer*" included "*Before/after every milking*", "*Daily*", "*Weekly*" and "*Rarer*".

For the questions regarding manual cleaning of the milking kit, numeric values were given to each frequency for each cleaning method based on Böhm (1998), giving the use of cold water between each milking a lower value than using hot water between each milking. The

sum of the values for each sub-question was calculated for each respondent and grouped into two new categories, "*Manual with a lower level of hygiene*" and "*Manual with a higher level of hygiene*". To achieve "*Manual with a higher level of hygiene*" the respondent must have answered that they use hot water or chlorine solution between each cow and hot water or chlorine solution between every milking.

In summary, questions 54, 55, 56.1, 56.2 and 56.3 were reduced to one question "*How is the colostrum milking kit cleaned?*", with four possible answers; "*Cleaned manually with a higher level of hygiene*", "*Cleaned manually with a lower level of hygiene*", "*Cleaned automatically between every cow or more frequent*" and "*Cleaned automatically after each milking or rarer*".

The reduction of answers and paths ensured that all questions within a section were answered by all respondents for the section, thereby preparing the data for further analysis.

2.4 Statistical methods

2.4.1 Multiple Correspondence Analysis

The reduced questionnaire consists of 63 questions with between two and five answers options for each. Questions from the sections 1, 2, 3, 4, 5, 6, 7, 9 and 10 in the questionnaire were included for the MCA. For section 3, only two questions were included, as the section consists of paths, and some respondents skipped many questions. Section 8 (Allocation of milk and feed for heifer calves) was not included because this section mostly contains questions on procedures less relevant for the neonatal heifer calves. Sections 11 and 12 were not included because only two respondents used group housing for new-born calves. Section 13 was not included because this section only concerns management procedures of bull calves. Furthermore, some questions with a low number of respondents within the chosen sections were not reduced, as they were difficult to combine with other questions. Herd size, number of properties and whether animals were bought, were included as supplementary questions. All included questions can be found in appendix 1.

Our data consist of a large number of questions (categorical variables) mostly concerning management procedures with unknown correlations. An MCA was chosen to investigate possible correlations between management procedures for calves in Danish dairy herds. MCA is a method that presents a summary of relations between more than two categorical

variables through a number of dimensions. The analysis produces a multidimensional space seeking to explain as much of the variance in the respondents' answers as possible. The dimensions are created with a decreasing amount of explained variance, so that the first dimension explains most of the variance. The amount of explained variance corresponds to the dimensions' eigenvalue. Questions, answers and objects (herds) that contribute more to the variance explained by the dimension will have a higher dimension loading on the specific dimension. Further, it is possible to include questions as supplementary, meaning that they do not contribute to the formation of the dimensions, but can be used in the interpretation of the dimensions (Di Franco, 2015).

After the creation of dimensions, it is possible to visualize questions, answers and herds in the multidimensional space in a 2-dimensional plot (biplot). The closeness of two answers corresponds to the correlation between them, in other words, the more frequently two answers of different questions are used in combination, the closer they will be plotted. Herds will be plotted depending on the loadings of their answers, meaning that two herds plotted closely together will have similar answers throughout the questionnaire. If answers have not been used by any respondents, the MCA will not include it, as it cannot explain any of the variance.

The MCA is sensitive to small variations in the data and will produce more robust results with a higher number of respondents per possible answer. There is no theoretical threshold for how many observations (respondents) that are required to produce stable results, but 20 observations per possible answer has been suggested (Di Franco, 2015).

2.4.1.1 Interpretation

There is no theoretical threshold for how many dimensions to include in the interpretation of the analysis. An empirical threshold is to include dimensions with eigenvalues of 1/Q (Q being the number of questions), as this is the mean of the eigenvalues, and dimensions with values above this will explain more variance than the average dimension (Husson, 2019).

Interpretation of the dimensions was performed by identifying the questions with the highest dimension loadings, with a minimum threshold of ≥ 0.30. Furthermore, the five herds with the highest dimension coordinate and the five herds with the lowest dimension

coordinates were identified, and their answers to the highest loading questions on each dimension were found and listed to assist interpretation of the meaning of the dimension.

The provided dimension coordinates for each herd on each dimension, makes it possible to identify herds with similar answers, and compare these to calf mortality data.

2.4.2 Multivariable logistic regression analysis

The multivariable logistic regression analysis was chosen, because it can be used to investigate and take into account the effect of multiple variables on a binary outcome. A model, with the probability of neonatal death for calves within 1-14 days of life as the outcome analyzed against the herd dimension coordinates (one for each dimension) as explanatory variables, was used for the analysis. Backward elimination was performed on a full model including both dimensions. Interactions between dimension coordinates from the MCA were not performed, as the MCA analysis accounts for this. Starting with the dimension with the highest p-value, a simpler model without this dimension was evaluated against the original model with a likelihood ratio test. If no significant difference ($p<0.05$) was found between these two models, the simpler model was chosen. After the final model was found, predicted values for the probability of death for neonatal calves were calculated using the model, and a graphical illustration generated of the mean and a 95% prediction interval (PI). The 95% PI was calculated using the equation

$$PI = \pm 1.96 * SE$$

SE Standard error of predicted values

1.96 z value corresponding to the 95% predictive level.

(Modulated from Samuels and Witmer, (2003) section 6.3)

Parameter estimate, 95% confidence interval (CI) and the p-value are presented for the final model. The results were considered statistically significant if the p-value was <0.05.

3. Results

3.1 Descriptive statistics

The final number of respondents was 81, as two of the included dairy herds did not respond to the questionnaire within the data collection period. The respondents were mainly herd owners involved in the running of the farm (n=54, 67%), followed by

operations managers with an overview of the entire operation (n=14, 17%), employees with responsibilities/tasks throughout the company (n=8, 10%), employees with responsibilities/tasks among calves/youngstock (n=3, 4%), and spouses helping with the running of the farm (n=2, 2%). At the time of responding, the herds had 318 cows on average, ranging from 100 to 989 cows.

Selected questions from the frequency analysis are presented in table 2. The entire analysis, including results from the questionnaire reduction and herd demographics, can be found in appendix 1. For questions with multiple answers possible, the sum can be more than 100%. Selected questions from the reduced questionnaire are presented in table 3.

Table 2: *Selected questions from the frequency analysis*

Question	Answers	Frequency
A) Have you purchased one or more animals within the last year? (n=81)	Yes	45.7%
	No	54.3%
6. Are the same tools used to both handle feed and for mucking out/cleaning? (for example, grip, broom, shovel, bucket, brush, dustpan) (n=81)	Yes	12.3%
	Yes, but they are always cleaned before/between use	18.5%
	Yes, but they are cleaned before/between use if dirty	17.3%
	No	51.9%
14. Where are the calves born indoors? (n=81)	In single calving pen(s) *(go to 15 – path 1)*	12.3%
	In common calving area *(go to 20 – path 2)*	58.0%
	In a common area with single pen(s) for the calving itself *(go to 20 – path 2)*	4.9%
	Both in single pen(s) and a common calving area *(go to 20 – path 2)*	24.7%
15. Are calving pens used for sick animals? (n=10)	Yes	10.0%
	Sometimes	60.0%
	No	30.0%
17. Is it possible for the calf to come into contact with other cows or manure from cows other than its own mother in the calving pen? (n=10)	Yes	60.0%
	Sometimes (for example, through bars)	40.0%
	Rarely	0%
	No	0%
21. Are risk-cows allowed in the common calving area (for example, cows with diarrhea, respiratory disorders, or cows testing positive for paratuberculosis, salmonella or the like)? (n=71)	Yes	8.5%
	Sometimes	11.3%
	No	69.0%
	Do not know	11.3%
29. How does the heifer calf receive colostrum? (n=81)	They exclusively get colostrum by suckling the dam *(go to 30 – path 1)*	8.6%
	They are given colostrum and can also suckle the dam (for example, at night) *(go to 34 – path 2)*	75.3%
	They are given colostrum and never suckle the dam *(go to 36 – path 3)*	16%
	None of the calves get any colostrum *(go to section 6)*	0%
36. How soon after birth are heifer calves typically given colostrum for the first time? (n=74)	Within 2 hours	10.8%
	Within 4 hours	36.5%
	Within 6 hours	39.2%
	More than 6 hours	13.5%
115. Which other animal groups do the milk-fed heifer calves have physical contact with? (multiple answers possible) (n=79)	None	78.5%
	Older heifer calves	19.0%
	Replacement heifers	5.1%
	Cows	6.3%
	Bull calves	2.5%

Table 3: *Selected reduced questions included in the MCA. References are used when relevant for the reduction.*

Question	Answers		Frequency
B) Herd size (n=69)	Small (<150 cows)		15.9%
	Medium (150-300 cows)		39.1%
	Large (>300 cows)		44.9%
C) Have you purchased animals within the last year? (n=69)	Yes		49.3%
	No		50.7%
D) *Reduced from question 5* How often are the following procedures done before the caretaking or handling of the milk fed calves? (n=81)	Changing or washing of boots	Regularly	39.5%
		If dirty	32.1%
		Rarely	28.4%
	Disposable gloves are used	Regularly	44.5%
		If dirty	2.5%
		Rarely	53.1%
E) *Reduced from question 29 and 36* How soon after birth are heifer calves typically given colostrum for the first time? (n=81) (Weaver et al., 2000)	Within 4 hours		43.2%
	> 4 hours		48.1%
	No control		8.6%
F) *Reduced from questions 44 and 45* How is the colostrum's antibody content checked before being given to heifer calves? (n=81) (Bielmann et al., 2010)	With Brix (refractometer), with limit ≥22		18.5%
	With Brix (refractometer), with limit ≤21		16.0%
	With colostrometer		8.6%
	Visually		16.0%
	Not checked		40.7%
G) *Reduced from questions 44 and 46* What is most often done with colostrum that does not meet the quality requirements? (n=81)	Used as colostrum		6.2%
	Only given to bull calves		16.0%
	Not used as colostrum		37.0%
	Not relevant (farmer does not check quality)		40.7%
H) *Reduced from question 120* How is the risk of disease transmission from sick calves handled in single/two-calf pens? (n=79) (Callan and Garry, 2002)	Handled with lower risk of transmission occurring		12.7%
	Handled with medium risk of transmission occurring		53.2%
	Handled with higher risk of transmission occurring		34.2%
I) *Reduced from question 124* If the calves have access to a dummy teat how often is this cleaned? (n=79)	Between calves		31.6%
	When dirty		11.4%
	Never		27.8%
	The calves do not have access to a dummy teat		29.1%

3.2 Multiple correspondence analysis

The final number of respondents included in the MCA was 69, and the final number of questions included in the MCA was 66, including the three supplementary questions. The lower number (than 81) is due to some respondents skipping sections irrelevant to them. Five respondents never fed whole milk or milk replacer to their calves (section 6), five respondents never fed waste milk to their calves (section 7) and two respondents did not keep new-born calves in single housing systems (section 9 and 10). The demographics for the 69 herds that have answered all sections, and that are included in the MCA, can be seen in appendix 2.

The MCA showed a total of 68 dimensions to explain all the variance. Two dimensions were examined, the amount of variance explained by dimensions 1 and 2 were 7% and 5.2%, respectively. To interpret the dimensions, questions with dimension loadings ≥0.30 for the two dimensions were chosen. The dimensions were named based on the questions with the highest dimension loadings (table 4).

- Dimension 1: "*Preventive measures related to colostrum, and hygiene when handling milk-fed heifers*". This dimension was characterized by whether the quality of colostrum is controlled, how the low-quality colostrum is handled, how long after birth the calves receive colostrum, how often disposable gloves are used and boots are washed or changed before handling calves, and how the risk of transmission of disease between calves is handled.
- Dimension 2: "*Herds size and dummy teat cleaning*". This dimension was characterized by the herd size and how often dummy teats are cleaned.

Table 4: *Variables with dimension loadings ≥0.30 were included for the two dimensions, which explained 12.2% of variance in total. Answers from the five highest scoring herds and five lowest scoring herds on each dimension are presented. Answers scoring low on the dimensions are marked with grey, intermediate scoring answers are marked with light grey. (n=69).*

	Questions	Dimension loading (R^2)	Answers from the highest scoring herds				Answers from the lowest scoring herds					
Dimension 1 (7 %)	Control of colostrum quality	*0,57*	Brix ≤21%	Brix ≥22%	Brix ≥22%	Brix ≥22%	Brix ≤21%	No control	No control	No control	No control	No control
	Use of disposable glove	*0,42*	Regularly	Regularly	Regularly	Regularly	Regularly	Rarely	Rarely	Rarely	Rarely	Regularly
	Handling transmission risk	*0,45*	Low risk	Low risk	Low risk	Medium risk	Low risk	Medium risk	High risk	High risk	High risk	High risk
	Use of low-quality colostrum	*0,45*	Not used	Used	Not used	Used for bull	Not used	No control	No control	No control	No control	No control
	Time after birth colostrum	*0,42*	<4 h	<4 h	<4 h	<4 h	<4 h	No control	No control	>4 h	No control	>4 h
	Frequency boot clean	*0,41*	Regularly	Regularly	Regularly	Regularly	Regularly	Rarely	Rarely	Rarely	Rarely	Rarely
Dimension 2 (5.2 %)	Herd size	*0,33*	Medium	Large	Large	Large	Large	Small	Medium	Small	Medium	Small
	Dummy cleaning	*0,34*	Between calves	Between calves	Between calves	Between calves	No dummy	Between calves	When dirty	When dirty	When dirty	Between calves

A biplot of the 45 answers contributing most to the variance explained by dimensions 1 and 2, and the position of respondents can be seen in figure 1. A larger version of the biplot can be found in appendix 3.

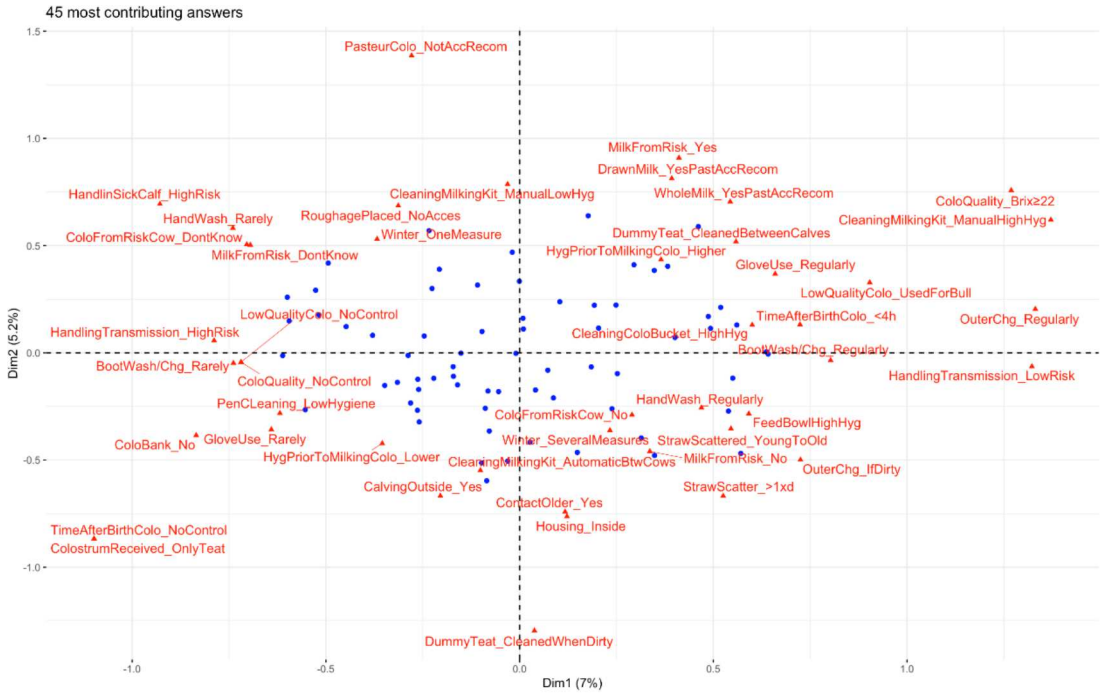

Figure 1: *Biplot showing the distribution of the 45 answers (red) contributing most to the variance explained by dimension 1 (horizontal) and dimension 2 (vertical). Blue dots show the distribution of herds.* **BootWash/Chg_Rarely**: Boots are rarely changed or washed before handling heifer calves. **BootWash/Chg_Regularly**: Boots are regularly changed or washed before handling heifer calves. **CalvingOutside_Yes**: Some or all of the calves are born outside during the summer. **CleaningColoBucket_HighHyg**: Cleaning of the bucket used for colostrum is done with a high level of hygiene. **CleaningMilkingKit_AutomaticBtwCows:** The milking kit used to milk colostrum is cleaned automatically between cows. **CleaningMilkingKit_ManualHighHyg:** The milking kit used to milk colostrum is cleaned manually with a high level of hygiene. **CleaningMilkingKit_ManualLowHyg**: The milking kit used to milk colostrum is cleaned manually with a low level of hygiene. **ColoBank_No**: Does not use a colostrum bank. **ColoFromRiskCow_DontKnow**: Do not know if calves receive colostrum from risk cows. **ColoFromRiskCow_No**: Calves never receive colostrum from a risk cow. **ColoQuality_Brix ≥22**: Colostrum quality is checked with brix, the minimum value used is ≥22% **ColoQuality_NoControl**: The farmer does not check the quality of the colostrum. **ColoReceived_OnlyTeat**: The calves only receive colostrum by suckling the dam. **ContactOlder_Yes:** The calves have physical contact with older animals. **DrawnMilk_YesPastAccRecom**: Waste milk is used for calves and is pasteurized according to recommendations. **DummyTeat_CleanedBetweenCalves**: The dummy teat is cleaned between calves. **DummyTeat_CleanedWhenDirty**: The dummy teat is cleaned when it is dirty. **FeedBowlHighHyg:** The heifer calves feed bowls are kept clean. **GloveUse_Rarely**: Disposable gloves are rarely used before handling heifer calves. **GloveUse_Regularly**: Disposable gloves are regularly used before handling heifer calves. **HandlingTransmission_HighRisk**: The risk of transmission from a sick calf is handled with a higher risk of transmitting disease. **HandlingTransmission_LowRisk**: The risk of transmission from a sick calf is handled with a lower risk of transmitting disease. **HandlinSickCalf_HighRisk**: When handling sick heifer calves, it is done with a higher risk of spreading diseases. **HandWash_Rarely**: Hands are rarely washed before handling heifer calves. **HandWash_Regularly**: Hands are regularly washed before handling heifer calves. **Housing_Inside**: The calves are housed inside. **HygPriorToMilkinColo_Higher**: The procedures used before milking colostrum are of higher hygiene. **HygPriorToMilkingColo_Lower**: The procedures used before milking colostrum are of lower hygiene. **LowQualityColo_NoControl:** The farmer does not check the quality of the colostrum. **LowQualityColo_UsedForBull:** Colostrum with a low quality is used for bull calves. **MilkFromRisk_DontKnow:** Do not know if milk from risk cows is fed to calves. **MilkFromRisk_No:** The calves never receive milk from risk cows. **MilkFromRisk_Yes**: Calves receive milk from risk cows. **OuterChg_IfDirty**: Outer layer is changed if it is dirty before handling heifer calves. **OuterChg_Regularly:** Outer layer is regularly changed before handling heifer calves. **PasteurColo_NotAccRecom:** Colostrum is pasteurized, but not according to recommendations. **PenCLeaning_LowHygiene:** The single housing pens are cleaned with a low level of hygiene. **RoughagePlaced_NoAcces**: The calves do not have access to roughage.**StrawScatter_>1xday**: Straw is scattered more than once daily.**StrawScattered_YoungToOld:** Straw is scattered in the order young to old calves. **TimeAfterBirthColo_<4h**: The calves receive colostrum within 4 hours after calving. **TimeAfterBirthColo_NoControl**: The calves only get colostrum by teat, and therefore there is no control with the time after birth before receiving colostrum. **WholeMilk_YesPastAccRecom**: Whole milk is used for calves and is pasteurized according to recommendations. **Winter_OneMeasure**: The farmer uses one aid to keep the calves warm and dry when it is cold. **Winter_SeveralMeasures**: More than one aid is used to keep the calves warm and dry when it is cold.

For the supplementary questions, herd size, whether animals have been bought within the last year and number of properties were included (figure 2). The mean positions of the herds belonging to each answer to the supplementary questions are marked with a larger

dot and surrounded by the confidence ellipse (CE). The answers are considered significantly different if the CEs do not overlap (Husson et al., 2017). For herd size the 95% concentration ellipses were also added, the concentration ellipse covers 95% of the herds in each answer.

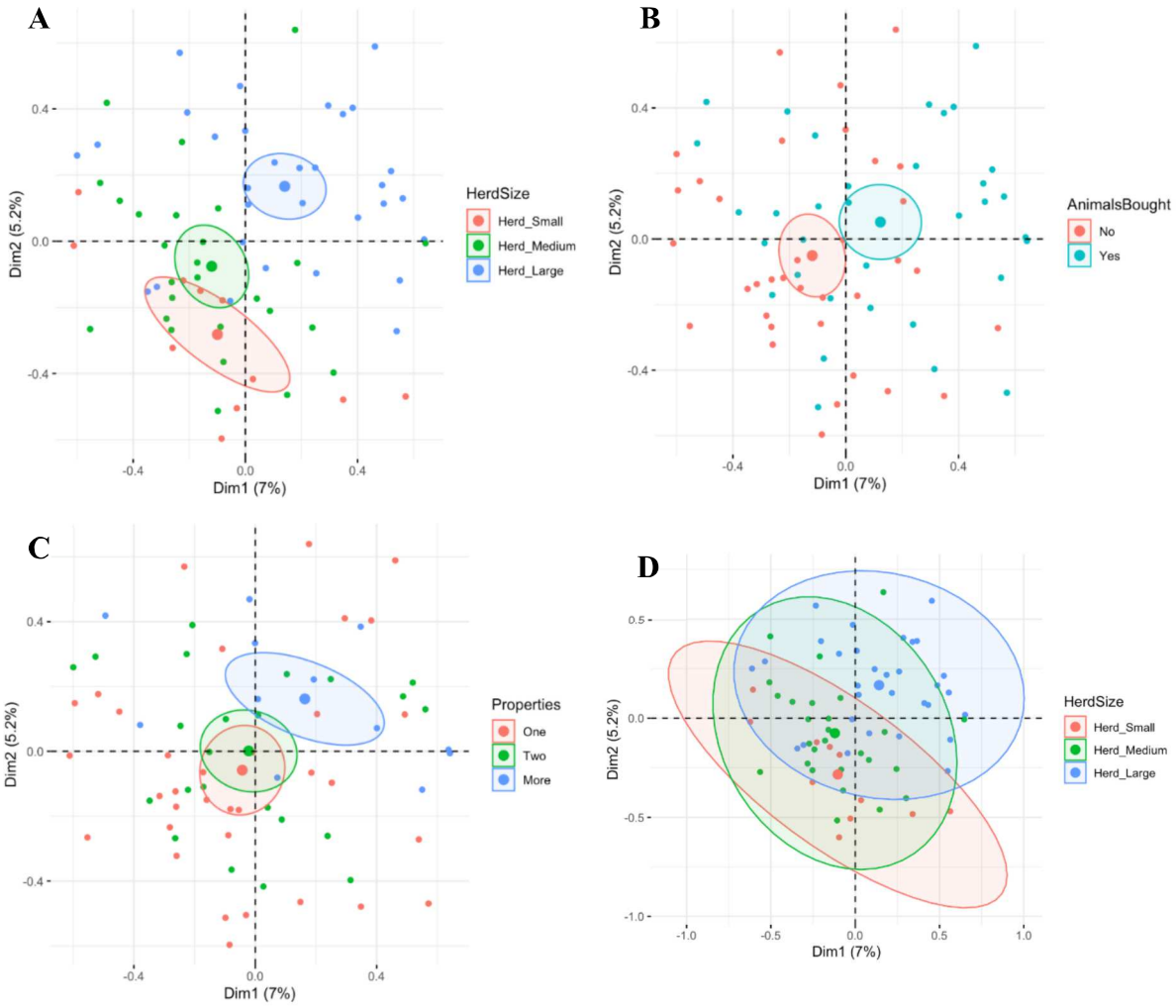

Figure 2: *Distribution of herds represented according to (A) herd size (small: <150 cows, medium: 150-300 cows, large: >300 cows), (B) whether animals are bought and (C) the number of properties. For each, the mean of the position of herds in each category is showed with a larger dot and its surrounding 95% CE. (D) shows the herd size with 95% concentration ellipses.*

The mean position of large herds is positioned towards the positive pole of dimension 2, but also towards the positive pole of dimension 1, while the mean position of medium herds is positioned more towards the negative pole of both the dimensions, and the mean position of small herds more towards the negative pole of dimension 2. There is no overlapping of the 95% CEs for the mean of large herds with medium and small herds, but

the 95% CEs for small and medium herds overlap. The 95% concentration ellipses for herd size overlap in all cases, but least between small and large herd size.

The mean position of herds that have bought one animal or more within the last year is positioned towards the positive pole of dimension 1, whereas the mean position of herds that have not bought animals within the last year is towards the negative pole of dimension 1. The 95% CEs for these do not overlap.

The mean positions of herds with one or two properties are positioned close to the centre of the dimensions. The mean position for herds with more than two properties is positioned towards the positive pole of both dimensions 1 and 2. The 95% CE for the mean position of herds with two properties overlaps with both herds with one, and herds with more than two properties, but the 95% CEs of these do not overlap.

3.3 Multivariable logistic regression analysis

Increasing values on dimension 1 was significantly ($p<0.001$) associated with lower probability of death, while dimension 2 was not found associated ($p=0.89$) with the probability of death in neonatal calves. The final model can be seen in table 5.

Table 5: *The final model for the multivariable logistic regression analysis.*

Coefficient	Estimate	95% CI	P-values
Intercept	-3.34	[-3.41; -3.27]	<0.001*
Dimension 1	-0.51	[-0.72; -0.30]	<0.001*

*Statistically significant with a p-value <0.05.

From the final model, the predicted probability of death was calculated for dimension 1 coordinates between –0.4 and 0.4, with an interval of 0.1. The predicted values with a 95% PI are shown in figure 3.

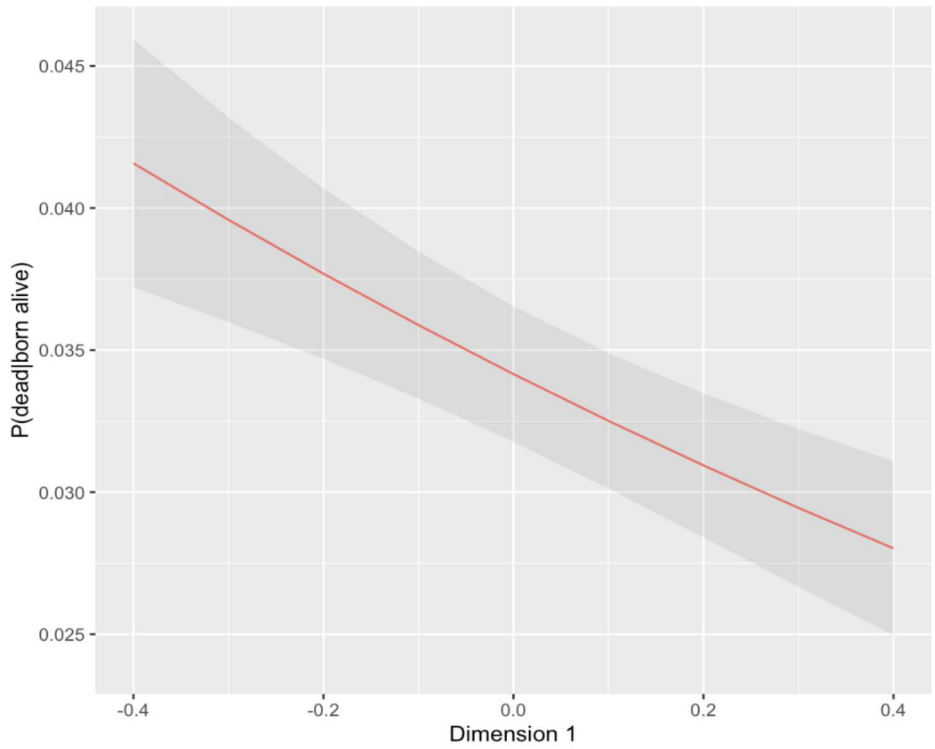

Figure 3: *The predicted effect of dimension 1 herd coordinates on the probability of death for neonatal calves within 1-14 days of life. Grey scale marks the 95% PI.*

4. Discussion

4.1 Frequency analysis

The frequency analysis was based on 81 respondents. The results were compared to frequency results of similar questions from questionnaires from Belgium (Sarrazin et al., 2014), Canada (Denis-Robichaud et al., 2019) and USA (Moore et al., 2010). We found that 30% of the respondents never use the calving pen for sick animals (table 2, question 15) similar to the 25-36% found in the other studies. In the question of whether calves are separated from older animals, 78.5% answered that the heifers had no contact with older animals (table 2, question 115), whereas this was only 30% and 58% in the studies from USA and Belgium, respectively. Additionally, in the question of whether the same utensils are used for both food and manure (table 2, question 6), we found 51.9% answered "*no*", whereas the studies from Canada and USA found that 64.8% and 75% answered "*no*", respectively. When asked whether animals from outside enter the herd, either through purchase or re-entry, questionnaires from other studies found that between 48-66% answered "*yes*" (Brennan and Christley, 2012; Denis-Robichaud et al., 2019; Moore et al.,

2010; Negrón et al., 2011; Renault et al., 2018; Sarrazin et al., 2014), whereas 45.7% in our study had purchased animals within the last year (table 2, question A).

Moore et al. (2010) was the study that differed most from our own, and the differences can be due to multiple reasons. Their aim was to refine a questionnaire, respondents were not selected at random, and questions were not completely comparable to our study. For example farmers were asked "*Do you limit nose to nose contact between animals from different stages and/or age groups*". Furthermore, it is important to keep in mind that differences in management procedures exist between countries, as stated by Nöremark et al. (2010). Considering the differences in practices for different countries, the frequency distribution of comparable questions from other studies did not differ considerably from our results.

From our frequency analysis we found that all heifer calves received colostrum (table 2, question 29), and only 8.6% had no control of the amount of colostrum given or the time of intake after birth, as these only receive colostrum by suckling from the dam. Most calves were said to receive their colostrum within a period of 6 hours after birth (table 2, question 36), however, the quality of the colostrum allocated was only checked with a refractometer or colostrometer by 43.1% (table 3, questions F). The quality of colostrum has been shown to be varying. A study found that 29% of the tested colostrum had an IgG level below 50 mg/mL (Morrill et al., 2012), which is the standard cut-off value corresponding to a brix value of 22% (Bielmann et al., 2010). This means, not checking the quality of the colostrum poses a risk that up to 29% of the calves in these herds receive colostrum with an insufficient level of IgG, and therefore potentially suffer from failure of passive transfer (Morrill et al., 2012). As stated in the introduction, colostrum allocation is an important part of internal biosecurity, as a correct allocation ensures the calf is more resistant towards the environment (Godden, 2008). The time after birth before the allocation is also of high importance, but might be of less significance if the colostrum given is of poor quality.

Another important biosecurity measure is to keep the exposure to pathogens as low as possible. A way of doing this is by keeping the calving pen as clean as possible. In our study, 12.3% answered that they exclusively use single calving pens (table 2, question 14), which has been shown to lower the risk of enteric and respiratory disease compared to a common calving area (Lorenz et al., 2011b). However, 60% of respondents using single

calving pens answered that it is possible for calves to come into contact with other cows or manure from other cows (table 2, question 17), thereby still posing a risk of transferring pathogens from the cows to the calf, even though single calving pens are used. According to Danish legislation, it is forbidden to keep cows infected with a transmittable disease in a calving area (Anonymous, 2017a). However, 19.8% answer that risk cows (such as cows testing positive for diseases) were always or sometimes allowed in the common calving area (table 2, question 21). This poses a risk of transmission of infectious diseases, as the new-born calf is very susceptible to pathogens before receiving colostrum.

The frequency analysis gives a broad overview of the management procedures applied for heifer calves in the included dairy herds. We found that the respondents answered that they performed several procedures that improve the level of biosecurity, but also found a lack of implementation of appropriate biosecurity measures, possibly resulting in a higher risk of spreading infectious diseases. There is therefore a potential for improvement with regards to the level of biosecurity when raising dairy calves, especially by using a more consistent approach to management procedures that improve the level of biosecurity.

4.2 Multiple correspondence analysis

The MCA showed 12.2% variance explained by two dimensions, and we found six and two questions to describe dimensions 1 and 2, respectively. The dimensions were named "*Preventive measures related to colostrum, and hygiene when handling milk-fed heifers*" and "*Herd size and dummy teat cleaning*". The amount of explained variance by the two dimensions might not seem like much, but it will always be underestimated when using a MCA (Greenacre, 2017). Our decision to include only two dimensions gave less explained variance, but left two interpretable dimensions with more than one question with dimension loadings ≥ 0.30.

When looking at the biplot (figure 1), most of the answers are distributed along dimension 1, with the exception of dummy teats being cleaned when they are dirty (low on dimension 2) and not pasteurizing colostrum according to recommendations (high on dimension 2). We saw that answers with higher levels of biosecurity were plotted high on dimension 1 and answers with lower levels of biosecurity were plotted low on dimension 1. These results from dimension 1 correspond well with the study by Denis-Robichaud et al. (2019), who also found that procedures with high biosecurity were plotted in proximity of each other and opposite of procedures with a low level of biosecurity.

The closeness of two answers corresponds to the correlation between them, and herds are plotted according to the respondents' answers. In summary, in herds plotted high on dimension 1 respondents answered that they use more procedures with a higher level of biosecurity than herds plotted low on dimension 1. However, we did not find a clear formation of clusters of the herds, meaning there is no clear separation of herds that only use either high or low biosecurity procedures, which implies that the management procedures used for calves are a mix of varying biosecurity levels within the herds.

From the supplementary questions (figure 2) we found that the mean positions of small and large herds were significantly differently placed in the 2-dimensional solution. This indicates an overall difference in the management procedures between small and large herd size. However, from the 95% concentration ellipses we found a large overlap between herd sizes, indicating that management procedures between herds of small and large size are not always different to each other. The same was found for the remaining supplementary questions. However, the three answers large herd, herds that have bought animals within the last year and herds with more than two properties are plotted closely, meaning that respondents from larger herds often answered "*yes*" to having bought animals and having more than two properties. Therefore, the differences between the answers to the supplementary questions might all be correlated.

The 95% CE of the mean position of large herds is placed on the positive pole of dimension 1, suggesting that large herds use more procedures with a higher level of biosecurity than small and medium herds, with their corresponding 95% CEs stretching more towards the negative pole of dimension 1. This corresponds well with the findings in the study by Denis-Robichaud et al., (2019), which found that large herds had a higher level of biosecurity than medium, small and very small herds.

In summary, the MCA produced patterns of management procedures, as those considered to be of a higher level of biosecurity were positioned towards the positive pole of dimension 1, and oppositely, the procedures with a lower level of biosecurity were positioned towards the negative pole of dimension 1. Biosecurity practices were not distributed considerably along dimension 2, instead, herd size was identified with a high loading on this dimension, indicating that herd size has an effect on management procedures, with small and medium herds having a tendency towards lower level biosecurity procedures. Even though a clear separation of herds was not seen, the MCA

provided us with knowledge and understanding of the dimensions, which is useful when comparing the dimensions with the probability of death in neonatal calves in the logistic regression analysis.

4.3 Multivariable logistic regression analysis

The multivariable logistic regression analysis showed that only dimension 1 coordinates had a significant effect, the probability of death was decreasing with increasing herd coordinate on this dimension. The effect of herd coordinates on dimension 2 were not significant, implying that herd size and the frequency of cleaning the dummy teat was not associated with the probability of death of neonatal calves within 1-14 days of life in this study. The PI used for the predicted model is similar to a CI, but uses the standard error of the predicted values and is wider than a CI. The slope of the curve cannot equal zero within the PI giving us a reassurance of the significance of our findings.

The herds scoring high on dimension 1 were characterized by controlling the quality of colostrum using a brix cut off value of ≥22%, not using colostrum with a low quality, giving colostrum to the new-born calves within 4 hours, regularly using disposable gloves and cleaning boots before handling calves, and handling sick calves with a low risk of disease transmission. Herds scoring low on dimension 1 were opposite, meaning that they did not control colostrum quality or time before allocation, rarely used disposable gloves or cleaned boots, and handled sick calves with a high risk of disease transmission. These results correspond with other studies, as the administration of high-quality colostrum received shortly after birth is important for the health and resistance of new-born calves (Bielmann et al., 2010; Godden, 2008; Lorenz et al., 2011b). Furthermore, a high level of hygiene is important to prevent disease transmission via, for example, hands and boots (McGuirk, 2008).

The results show that preventive measures related to colostrum, and hygiene when handling milk fed heifers is negatively correlated with the probability of death for neonatal calves within 1-14 days of life. The dimension 2 coordinates had no significant effect on the probability of death, with herd size loading high on this dimension. This result conflicts with the findings in the studies by Bleul (2011) and Gulliksen et al. (2009), which both found a higher mortality rate for neonatal calves in larger herds. However, these studies were based on smaller herds than the ones used in our study, and the cause of

the findings might be a result of differences in management procedures, as also implied by Gulliksen et al. (2009).

4.4 Limitations

4.4.1 Data collection

In this study, the included herds were dairy herds supplying calves for veal calf producers. Dairy herd owners with an interest in research and biosecurity might have been more likely to accept the invitation to join the "Robust Calves" project. As shown by (Laanen et al., 2014), farmers with an interest in the subject also believe more in the benefits of implementing biosecurity measures. Furthermore, dairy herds were chosen based on their large size, to ensure a sufficiently high number of calves being available for the project sampling, which means this could give a larger average farm size than the population average, and our findings could therefore be based on a higher level of biosecurity, than could have been found by random selection (Denis-Robichaud et al., 2019).

The average number of cows in the 81 responding dairy herds was 318, compared to an average of 216 cows per herd included in the Danish Milk Recording (RYK) in 2018, with 90% of Danish dairy herds included in RYK (SEGES, 2019). The 81 respondents are only a small fraction of the total number of Danish dairy herds (~2700, (SEGES, 2020b)), and to make sure the frequencies in management procedures found in this study corresponds to those for all Danish dairy herds, it would be necessary to conduct a larger study with randomly selected study herds.

4.4.2 Respondents

The respondents were mainly herd owners involved in running the farm, and operation managers with an overview of the entire operation. Only 4% of the total respondents were employees with responsibilities/tasks among calves/youngstock. Herd owners and operation managers will most likely be involved in the planning of management procedures regarding calves, but not necessarily in the daily execution of the procedures, and some inconsistency could occur between plans and practical execution. Furthermore, there is a possibility that the respondent knows which answer will give the highest biosecurity score and has chosen this as opposed to the actual management procedures performed. To accommodate for these possible disagreements, a quality assurance study could be performed, as done in the study by Ramvad et al. (2016).

4.4.3 The BioSecure questionnaire

The BioSecure questionnaire was developed by Danish researchers to fit Danish dairy farms and the management procedures commonly used for dairy calves. The questionnaire only concerns areas of the dairy herd relevant to calf biosecurity and mainly involves internal biosecurity measurements, with the exception of questions regarding the possibility of birds, cats and dogs coming into contact with the calves' feed or bedding, and the procedures for the collection of calves for veal production.

At the beginning of the questionnaire, respondents fill in information about the herd, including how many animals have been purchased within the last year and the number of herds they have been purchased from. These questions also regard external biosecurity, but no further questions on the practices associated with the introduction of new animals to the herd were asked, as otherwise observed in other questionnaires regarding biosecurity (Brennan and Christley, 2012; Renault et al., 2019; Sarrazin et al., 2014). The study by Brennan and Christley (2012) used a questionnaire that additionally contained questions on the movement of animals out of the herd, and procedures related to this. Questions on external biosecurity are valuable in determining the risk of spreading diseases between herds, and especially in identifying herds that propose a risk in case of a disease outbreak. Our results are therefore mainly based on information about internal biosecurity levels and do not assess the current application of external biosecurity measures in Danish dairy farms.

Several countries have developed questionnaires to investigate the biosecurity levels in cattle herds. At the University of Ghent, a questionnaire entitled Biocheck.UGhent™ was developed, initially to investigate the biosecurity level in Belgian pig herds, but a cattle specific questionnaire has later been developed. Biocheck Cattle covers biosecurity measures for the whole herd, but asks more general questions, and less detail about the procedures. For example, Biocheck asks "*Is the colostrum checked for sufficient quality?*", with possible answers: "*Yes*" and "*No*", whereas the BioSecure questionnaire asks if and how the colostrum quality is checked, and, if checked, what thresholds are used to determine if the quality is high enough (question 44 and 45 in appendix 1).

In Canada a questionnaire was developed to describe the current adoption of biosecurity on Canadian dairy farms. The questionnaire contains questions regarding the whole herd which, similarly to the Belgian Biocheck questionnaire involve less detail regarding

procedures than BioSecure. For example, there is only one question regarding the allocation of colostrum ("*How often do you allow new-borns to nurse the dam"*), with four possible answers ("*Always*", "*Most of the time*", "*Occasionally*", "*Never*") (Denis-Robichaud et al., 2019), whereas BioSecure has a whole section with 14 questions regarding the allocation of colostrum (table 1, section 3).

The BioSecure questionnaire contains very detailed questions on the management procedures for calves. It can be useful both as an advisory tool in cooperation with a veterinarian or herd health advisor, and for self-assessment, as the respondents' biosecurity score is presented and compared to the average score of all other respondents, following completion. It is a valuable tool to investigate the level of calf related biosecurity, but is inadequate when it comes to the remaining areas of the herd and external biosecurity.

4.4.4 Multiple correspondence analysis

The total number of respondents who answered all questions included in the MCA might not be enough to produce robust results. As previously mentioned, a minimum of 20 respondents per answer is suggested by Di Franco (2015). Our final number of 69 respondents, 63 questions and 171 possible answers, indicates that our results are instable by possibly being sensitive to additional data input, and might be difficult to replicate if performed with more respondents. We included two dimensions in the interpretation of the analysis, as opposed to the suggested threshold of dimensions with eigenvalues above 1/Q, thus making the interpretation and presentation of our results more feasible. The suggested threshold would include 35 dimensions, which would not contribute greatly to the overall understanding, as many of these dimensions each explain a very small amount of variance.

To make sure all respondents answered all questions in the MCA, we reduced several of the questions. Because of the reduction we lost some degree of detail in the questionnaire and forced some respondents into answers, that probably does not fit their current procedures completely. One example of this includes the questions regarding the order of feeding and caretaking of young calves, where the answers "*it varies*" and "*from oldest to youngest*" were combined. This was done to create a more profound difference between the answers, but the risk of a disease spreading will be greater if a procedure with a low level of biosecurity happens always, compared to sometimes. This can be described with the equation:

$$P(n) = 1 - (1 - p)^n$$

Where *P(n)* is the risk of transmission as a function of *n*, *p* is the risk of transmission every time a procedure is done, and *n* is the number of times the procedure is done (modulated from Houe et al., (2004), page 86, with inspiration from Laanen et al., (2010)).

This means that respondents who often use procedures with a high level of biosecurity, but sometimes with a low level of biosecurity, will be categorized as respondents who always use the procedure with a low level of biosecurity. This results in our MCA possibly being established on a lower level of biosecurity than is actually the case. Additionally, some questions were left out from the MCA, resulting in a more stable MCA, but also less information about the herds' biosecurity levels included.

Even though the MCA was based on an observation number much lower than the recommended, interpretable results corresponding with studies of the similar nature from other countries were found.

4.4.5 Multivariable logistic regression analysis

The mortality data used in the model is from the period of 12 months prior to answering the questionnaire. This was chosen because the respondents receive a report with an overall score and scores for each section, after filling in the online questionnaire. After receiving the scores, the farmer might have changed perceptions regarding their level of biosecurity, and therefore changed management procedures that could possibly have affected the calf mortality, and our study.

The questionnaire regarding milk fed calves in dairy herds mainly concerns management procedures for heifer calves, but mortality data for both heifer and bull calves, including crossbreeds, were included in the analysis. By including bulls and crossbreeds, the amount of mortality data available more than doubled. Furthermore, it was assumed that if the farmer has a high level of biosecurity for the procedures concerning heifer calves, this is probably also valid for the bull and crossbred calves. This assumption might affect our results, for example, as seen in question G, table 3, 16% of the respondents use colostrum that does not meet the quality requirements for bull calves. This puts the bull calves at risk for failure of passive transfer (Morrill et al., 2012), and could thereby increase the probability of death in herds that possibly have high levels of biosecurity for management of heifer calves.

The herds' coordinate on dimension 1 showed a significant negative correlation with the probability of death for neonatal calves, corresponding to literature. However, the dimension coordinates used as variables in the multivariable logistic regression model are based on a possibly instable MCA, which might cause the results to be nonreplicable.

Conducting a study with a larger sample size, and possibly interview or observation-based questionnaires would be of great interest. This would both accommodate the problem of few respondents and the need for a quality assurance study, although it would be expensive and more time consuming.

5. Conclusion

Biosecurity is important to avoid the spread of diseases within and between dairy farms. In order to obtain a high level of biosecurity, focus on management procedures is essential.

In this study, the BioSecure questionnaire has proven useful in quantifying internal biosecurity related procedures used for heifer calves in Danish dairy herds. The level of implementation of biosecurity measures regarding milk-fed calves in the investigated herds has shown that the current application of biosecurity is insufficient in many herds, with several procedures of a high level of biosecurity performed by most of the respondents, but other procedures considered important to a high level of biosecurity lacking in implementation. Farmers should therefore be advised to have a more holistic approach to biosecurity related management procedures.

An MCA was performed on reduced questions from selected sections of the BioSecure questionnaire. Two dimensions, explaining 12.2% variance, were interpreted. The MCA demonstrated patterns in management procedures, with high biosecurity positioned high on dimension 1, and low biosecurity positioned low on dimension 1. Herd size was found to effect the management procedures used. The MCA also showed that herds did not cluster into groups with an overall high or low level of biosecurity. Again, a more consequent implementation of biosecurity is urged.

A multivariable logistic regression analysis showed significant negative correlation between using preventive measures related to colostrum and having a high level of hygiene when handling milk-fed heifers, and the probability of death for neonatal calves

within 1-14 days of life. This result can be used as a motivational factor for farmers when implementing management procedures to improve internal biosecurity.

The findings of our study can hopefully be used to contribute to a larger focus on biosecurity related management procedures regarding milk-fed calves in Danish dairy herds. It can be an encouragement for dairy farmers to improve the level of biosecurity, lower the mortality rates and ensure a healthier production, benefitting the entire Danish dairy industry.

6. Perspectives

Several studies in different countries have used questionnaires to identify the level of biosecurity in husbandry productions. With the Danish dairy industry's aim to reduce the use of antibiotics and the mortality rate, restrictions to the use of antibiotics might be implemented, along with a threshold for calf mortality, with sanctions to herds that exceed the limit. Prevention, instead of treatment, will be of importance, causing an increased need to implement both internal and external biosecurity measures. To assess the areas lacking biosecurity, further studies on the overall implementation of biosecurity regarding the whole herd, and external biosecurity, is needed. This would include developing a questionnaire specifically for these areas, or the adjustment of a questionnaire from abroad, to fit Danish herds. Further, a higher number of respondents is advised, as the low number of respondents was a limitation in our study. To achieve this, a cooperation with bovine veterinary practices all over the country could be initiated, as they could help include farmers to answer the questionnaire and collect permits to access production data for comparison.

In the future, a study investigating production parameters of lactating cows and calf management procedures could determine possible long-term consequences and work as a motivational factor to engage farmers. For example, it would be interesting to investigate the effect of management procedures used for heifer calves and milk yield, health status, reproduction parameters and antibiotic use, either as a cross sectional study, or in a cohort study, following the heifer calves through their lives as cows.

An intervention study using the BioSecure questionnaire to identify areas with low biosecurity, followed by intensive veterinary counselling and change in management

procedures is of interest. Health parameters and mortality data can be compared before and after the intervention, giving more precise results on the effects of management procedures on the health and vitality of calves. Personality test on farmers and different approaches to counselling could be tested and investigated for effect, giving a better idea of which approaches to use for different types of farmers.

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Appendix 1

Herd demographics for all respondents				
	n	**Mean**	**Min**	**Max**
Number of properties	81	1.7	1	5
Number of cows in the herd	81	322	100	989
	n	**Median**	**Min**	**Max**
Number of herds bought from (44 herds have not bought animals within the last year)	37	1	1	11
Number of animals bought	37	79	1	419

Section 1 – General biosecurity among milk-fed heifer calves						
Question	Subquestions	Answers	Frequency	New question	Answers	Frequency
1. In what order are the following feeding and caretaking routines performed with the young heifer calves? (n=81)	1.1 Calves are fed with milk	From youngest to oldest	55.6%	In what order are the young heifer calves fed with milk (n=81)	From youngest to oldest	55.6%
		From oldest to youngest	4.9%		From oldest to youngest	44.4%
		It varies	39.5%			
	1.2 Other feeding of calves	From youngest to oldest	30.9%	In what order are the young heifer calves fed with other feeding? (n=81)	From youngest to oldest	30.9%
		From oldest to youngest	4.9%		From oldest to youngest	69.1%
		It varies	64.2%			
	1.3 Straw scattering of calf pens	From youngest to oldest	24.7%	In what order is straw scattering of calf pens done among the young heifer calves (n=81)	From youngest to oldest	24.7%
		From oldest to youngest	1.2%		From oldest to youngest	75.3%
		It varies	74.1%			
2. How many people are involved in caretaking of the calves during a week including the weekend? (n=81)		1	3.7%	How many people are involved in caretaking of the calves during a week including the weekend? (n=81)	1-2	49.4%
		2	45.7%			
		3	35.8%		>2	50.6%
		>3	14.8%			

3. How is the work distributed between the calf caretakers during the week? (n=81)		Always the same calf caretaker(s) on both weekdays and weekends	59.3%	How is the work distributed between the calf caretakers during the week? (n=81)		By the same caretakers	66.7%
		Always the same calf caretaker(s), but not on weekends	19.8%				
		Always the same calf caretaker(s), but not on weekdays	0%			By variating caretakers	33.4%
		Fixed calf caretaker(s), replaced only a few times per year	7.4%				
		It varies a lot	13.6%				
4. Is the caretaking of the calves performed systematically with fixed daily procedures? (n=81)		Yes, no matter who takes care of the calves	84%	Is the caretaking of the calves performed systematically with fixed daily procedures? (n=81)		Yes, always	84%
		It varies depending on who takes care of the calves	13.6%			Not always	16.1%
		There are no fixed procedures	2.5%				
5. How often are the following done before the caretaking or handling of milk-fed calves? (n=81)	5.1 Changing or washing of boots	Every time	21%	How often are the following done before the caretaking or handling of milk-fed calves? (n=81)	Changing or washing of boots	Regularly	39.5%
		Often	18.5%				
		If visibly dirty	32.1%			If dirty	32.1%
		Rarely	7.4%			Rarely	28.4%
		Never	21%				
	5.2 Changing of outerwear	Every time	1.2%		Changing of outerwear	Regularly	6.1%
		Often	4.9%				
		If visibly dirty	14.8%			If dirty	14.8%
		Rarely	9.9%			Rarely	79%
		Never	69.1%				
	5.3 The hands are washed with soap	Every time	17.3%		The hands are washed with soap	Regularly	37.1%
		Often	19.8%				
		If visibly dirty	35.8%			If dirty	35.8%
		Rarely	4.9%			Rarely	27.1%
		Never	22.2%				
	5.4 Disposable gloves are used	Every time	27.2%		Disposable gloves are used	Regularly	44.5%
		Often	17.3%				
		If visibly dirty	2.5%			If dirty	2.5%
		Rarely	13.6%			Rarely	53.1%

	Never	39.5%			
6. Are the same tools used to both handle feed and for mucking out/cleaning? (for example, grip, broom, shovel, bucket, brush, dustpan) (n=81)	Yes	12.3%	Are the same tools used to both handle feed and for mucking out/cleaning? (for example, grip, broom, shovel, bucket, brush, dustpan) (n=81)	Yes	48.1%
	Yes, but they are always cleaned before/between use	18.5%			
	Yes, but they are cleaned before/between use if dirty	17.3%			
	No	51.9%		No	51.9%
7. Are ALL tools used with milk-fed calves separate tools ONLY used in this section of the stable? (grip, broom, shovel, bucket, brush, dustpan and similar) (n=81)	Yes	49.4%	Are ALL tools used with milk-fed calves separate tools ONLY used in this section of the stable? (grip, broom, shovel, bucket, brush, dustpan and similar) (n=81)	Yes	49.4%
	No, but they are always cleaned before use	13.6%		No	50.6%
	No, but they are always cleaned before use if dirty	11.1%			
	No	25.9%			
8. Are high-pressure cleaners used for washing inventory (for example, hutches, pens, machinery, hoof trimming box, tools)? (n=81)	Yes, cold water high-pressure cleaner *(go to 9 – path 1)*	39.5%	How does cleaning of inventory take place? (n=81) Pedersen (2017) recommends not using a high-pressure cleaner in the proximity of calves, and using detergent and a disinfectant when cleaning inventory.	High-pressure cleaning with higher risk of vapor clouds reaching the calves	64.2%
	Yes, hot water cleaner *(go to 9 – path 1)*	40.7%		High-pressure cleaning with lower risk of vapor clouds reaching the calves	16.0%
	No *(go to 12 – path 2)*	19.8%		By manual cleaning with higher level of hygiene	12.3%
9. How often are high-pressure cleaners used inside stables with calves? (n=65)	Regularly	15.4%		By manual cleaning with a lower level of hygiene	7.4%
	Rarely	29.2%			
	Never	55.4%			
10. Is it possible that water spray or vapor clouds can reach calves during high-pressure cleaning? (n=65)	Yes	32.3%			
	Possibly through doors, nets, windows or similar	21.5%			
	No	46.2%			
11. What is the shortest distance to calves during high-pressure cleaning? (n=65) *(go to 13)*	Less than 10 meters	47.7%			
	10-20 meters	26.2%			
	More than 20 meters	26.2%			

12. How does cleaning of inventory take place? (If not by high-pressure) (n=16) *(go to 13)*	Rinsed with water	0%			
	Rinsed with cold water and brush	0%			
	Washed with cold water, brush and detergent	0%			
	Washed with hot water and brush	0%			
	Washed with hot water, brush and detergent	6.2%			
	Scrape the manure off the inventory	37.5%			
	Scrape the manure and lime off the inventory	56.2%			

Section 2 – Calving and the newborn calf (not reduced or analyzed with multiple correspondence analysis)					
Question	Answers	Frequency	New Question	Answers	Frequency
13. Are calves born outside during Summer? (n=81)	Yes, all/most of them	3.7%	Are calves born outside during Summer? (n=81)	Yes	18.5%
	Yes, some of them	14.8%			
	No	81.5%		No	81.5%
14. Where are the calves born indoors? (n=81)	In single calving pen(s) *(go to 15 - path 1)*	12.3%	Where are the calves born indoors, and what level of hygiene is the area kept with? (n=81)	Single calving pen with a lower risk of transmission of diseases	0%
	In common calving pen/area *(go to 20 – path 2)*	58.0%			
	In the common area with single pen for the calving itself *(go to 20 – path 2)*	4.9%			
	Both in single pen(s) and common calving area *(go to 20 – path 2)*	24.7%			
15. Are calving pens used for sick animals? (n=10)	Yes	10.0%		Single calving pen with a higher risk of transmission of diseases	12.3%
	Sometimes	60.0%			
	No	30.0%			

16. Is the calving pen cleaned thoroughly after sick animals have been in it? (n=7)	Yes	28.6%			
	Sometimes	28.6%			
	No	42.9%			
17. Is it possible for the calf to come into contact with other cows or manure from cows other than its own mother in the calving pen? (n=10)	Yes	60.0%		Common calving pen with a lower risk of transmission of diseases	14.8%
	Sometimes (for example, through bars)	40.0%			
	Rarely	0%			
	No	0%			
18. How is/are the calving pen(s) cleaned? (n=10)	Remove accumulated manure and scatter straw	10.0%			
	Muck out (remove all manure and straw)	60.0%			
	Muck out and add lime to the pen	0%		Common calving pen with a higher risk of transmission of diseases	72.8%
	Muck out and scrape manure off the inventory	0%			
	Muck out, scrape manure off the inventory, and add lime to the box	20.0%			
	Muck out, wash/hose down the area	10.0%			
	Muck out, wash/hose down the area and disinfect (for example, with lime)	0%			
	Muck out, wash/hose down the area, let it dry out, then disinfect (for example using lime)	0%			
19. How often is/are the calving pen(s) thoroughly cleaned? (n=10) *(go to 25)*	After every calving	10.0%			
	After every 2th-3rd calving	20.0%			
	After every 4th-6th calving	50.0%			

	After every 7th-10th calving	0%			
	Less frequent	20.0%			
20. Are sick animals kept the common calving area? (n=71)	Yes	8.5%			
	Sometimes	29.6%			
	No	62.0%			
21. Are risk-cows allowed in the common calving area (for example, cows with diarrhea, respiratory disorders, or cows testing positive for paratuberculosis, salmonella or the like)? (n=71)	Yes	8.5%			
	Sometimes	11.3%			
	No	69.0%			
	Do not know	11.3%			
22. What is the highest number of cows in the same calving area? (n=71)	4 or fewer	18.3%			
	5-8 cows	29.6%			
	9-12 cows	25.4%			
	13-16 cows	8.5%			
	More than 16	18.3%			
23. How much space does each cow have in the calving area? (n=71)	Up to 4 m2 per cow (2x2 m)	16.9%			
	5-9 m2 per cow	59.2%			
	10-16 m2 per cow	19.7%			
	More than 16 m2 per cow (4x4 m)	4.2%			
24. Is it possible that the calf can come into contact with other cows or manure from cows other than its own mother in the calving area? (n=71) *(go to 25)*	Yes	69.0%			
	Sometimes (for example, at night)	29.6%			
	Rarely	1.4%			
	No	0%			
25. Is a temporary pen (up to 2 days) or a transport cart used for newborn heifer calves (for example, a calf incubator, single pen or transport cart)? (n=81)	Yes, for all heifer calves	11.1%	Is a temporary pen (up to 2 days) or a transport cart used and what is the risk transmission of disease from the cart? (n=81)	Not used	79.0%
	Yes, for heifer calves who are weak at birth	1.2%			
	Yes, for all heifer calves, when it is cold	3.7%			
	Yes, for heifer calves who are weak at birth, when it is cold	4.9%		Used with a lower risk of transmission of disease	8.6%
	No	79.0%			

26. Which of the following is used for cleaning the temporary box/cart/incubator? (multiple answers possible) (n=17)	Visible dirt is removed manually	35.3%			
	Cold water	41.2%			
	Hot water	29.4%			
	Detergent	29.4%		Used with a higher risk of transmitting disease	12.3%
	Brush	5.9%			
	Drying out	17.6%			
	Disinfection (for example with lime, disinfectant)	23.5%			
	None of the above	0%			
27. How often is the temporary box/cart/incubator cleaned? (n=17)	When it is dirty	41.2%			
	Before/after EVERY calf	23.5%			
	After every 2nd-3rd calf	11.8%			
	After every 4th-7th calf	17.6%			
	Less frequent	0%			
	It varies	5.9%			
28. What aids are used to keep the heifer calf warm and dry when it is cold? (multiple answers possible) (n=81)	Extra bedding in the pen	81.5%	Are any aids used to keep the heifer calf warm and dry when it is cold? (n=81)	Yes, one aid is used	35.8%
	Heat lamp for all newborns	6.2%			
	Heat lamp for the sick/weak at birth	14.8%			
	Blanket for all calves	34.6%		Yes, more than one aid is used	61.7%
	Blanket for calves who are sick/weak at birth	37.0%			
	Cover/curtains for protection against draft	18.5%			
	Heating in pen/barn/section	1.2%		No, none of the aids are used	2.5%
	Other	1.2%			
	None of the above	2.5%			

Section 3 – Allocation of colostrum							
Question	Subquestions	Answers	Frequency	New question	New subquestions	Answers	Frequency
29. How does the heifer calf receive colostrum? (n=81)		They exclusively get colostrum by suckling the dam *(go to 30 – path 1)*	8.6%	How does the heifer calf receive colostrum? (n=81)		Only by teat	8.6%
		They are given colostrum and can also suckle the dam (for example, at night) *(go to 34 – path 2)*	75.3%			Teat and manual allocation	75.3%
		They are given colostrum and never suckle the dam *(go to 36 – path 3)*	16%			Only manual allocation	16%
		None of the calves get any colostrum *(go to section 6)*	0%			Never given colostrum	0%
30. Is the udder always clean when the heifer calf drinks colostrum from the dam? (n=7) *(From path 1 – colostrum only given by suckling dam)*		Yes, always	14.3%	*Not reduced or included in MCA*			
		Usually	71.4%				
		No	14.3%				
34. Is the udder always clean when the heifer calf drinks colostrum from the dam? (n=61) *(From path 2 – colostrum both from suckling dam and allocated manually)*		Yes, always	9.8%				
		Usually	70.5%				
		No	19.7%				
31. How long do heifer calves stay with the dam? (n=7) *(From path 1 – colostrum only given by teat)*	31.1 Average	Up to 12 hours	14.3%				
		12-24 hours	42.9%				
		1-2 days	42.9%				
		More than 2 days	0%				
	31.2 Maximum	Up to 12 hours	0%				
		12-24 hours	28.6%				
		1-2 days	71.4%				
		More than 2 days	0%				
35. How long do heifer calves stay with the dam?	35.1 Average	Up to 12 hours	73.8%				
		12-24 hours	16.4%				
		1-2 days	8.2%				

(n=61) *(From path 2 – colostrum both from teat and manual allocation)*		More than 2 days	1.6%
	35.2 Maximum	Up to 12 hours	54.1%
		12-24 hours	29.5%
		1-2 days	13.1%
		More than 2 days	3.3%
32. How many of the heifer calves need help drinking colostrum (for example, finger in the mouth, using a tube)? (n=7)		All	14.3%
		Many	0%
		Half of them	14.3%
		A few	42.9%
		None	28.6%
33. Are there fixed procedures for hand hygiene before helping the heifers drink (for example, finger in mouth, using a tube)? (n=5) *(From path 1 – colostrum only given by teat, only answered by those who give drinking aid) (go to 43)*		New disposable gloves are used every time	0%
		New disposable gloves are used, if hands are visibly dirty	0%
		The hands/gloves are rinsed	20%
		The hands are washed with soap every time	20%
		The hands are washed with soap and alcohol applied every time	0%
		Alcohol applied to hands every time	0%
		The hands are washed, if they are visibly dirty	20%
		There are no fixed procedures	40%
41. Are there fixed procedures for hand hygiene before helping the heifers drink (for example, finger in mouth, using a tube)? (n=74) *(From path 2 – colostrum both from teat and manual allocation)*		New disposable gloves are used every time	24.3%
		New disposable gloves are used, if hands are visibly dirty	9.5%
		The hands/gloves are rinsed	17.6%

	The hands are washed with soap every time	12.2%			
	The hands are washed with soap and alcohol applied every time	2.7%			
	Alcohol applied to hands every time	1.4%			
	The hands are washed, if they are visibly dirty	13.5%			
	There are no fixed procedures	18.9%			
36. How soon after birth are heifer calves typically given colostrum for the first time? (n=74)	Within 2 hours	10.8%	How soon after birth are heifer calves typically given colostrum for the first time? (n=81) (Godden, 2008)	Within 4 hours	43.2%
	Within 4 hours	36.5%		>4 hours	48.1%
	Within 6 hours	39.2%		No control	8.6%
	More than 6 hours	13.5%			
37. When can it take more than 6 hours for the heifer calves to be given their first colostrum? (multiple answers possible) (n=74)	Never, they are ALWAYS getting colostrum within 6 hours	12.2%	*Not reduced or included in MCA*		
	It varies	12.2%			
	In the weekend	16.2%			
	At night	79.7%			
	In the middle of the day	6.8%			
	In case of illness/absence among the staff	5.4%			
	If there is not enough staff	9.5%			
	During training of new staff	2.7%			
	During holiday periods	10.8%			
	When busy with work in the fields	6.8%			
	In other situations	6.8%			
38. How long can it take, in a worst-case scenario, before a heifer calf receives its first colostrum? *(both path 2 and 3)* **(n=74)**	Up to 6 hours	32.4%			
	Up to 9 hours	37.8%			
	Up to 12 hours	24.3%			
	More than 12 hours	5.4%			

39. How many liters of colostrum do heifer calves get at their first feeding? (n=74)	39.1 Large dairy breed (for example Holstein)	Not relevant	1.4%	
		0 L	0%	
		½ L	0%	
		1 L	0%	
		1½ L	0%	
		2 L	1.4%	
		2½ L	8.1%	
		3 L	20.3%	
		3½ L	12.2%	
		4 L	56.8%	
	39.2 Small dairy breeds (Jersey)	Not relevant	77%	
		0 L	0%	
		½ L	0%	
		1 L	0%	
		1½ L	0%	
		2 L	4.1%	
		2½ L	1.4%	
		3 L	8.1%	
		3½ L	2.7%	
		4 L	6.8%	
	39.3 Mixed-breed calves	Not relevant	23%	
		0 L	0%	
		½ L	0%	
		1 L	0%	
		1½ L	0%	
		2 L	2.7%	
		2½ L	4.1%	
		3 L	17.6%	
		3½ L	8.1%	
		4 L	44.6%	
40. How many times are heifer calves given colostrum? (n=74)		1 time	54.1%	
		2 times	16.2%	
		3-4 times	17.6%	
		5-6 times	12.2	
		7-10 times	0%	
		More than 10 times	0%	
42. What is used for cleaning of equipment for feeding of colostrum? (for example tube,	42.1 Cold water	Not used	67.6%	
		Before/after every feeding	20.3%	
		Daily	6.8%	
		Weekly	2.7%	
		Less frequent	2.7%	
	42.2 Hot water	Not used	4.1%	

bottle, drinking-bucket, bowl) (n=74)		Before/after every feeding	71.6%	
		Daily	20.3%	
		Weekly	2.7%	
		Less frequent	1.4%	
	42.3 Detergent	Not used	25.7%	
		Before/after every feeding	29.7%	
		Daily	14.9%	
		Weekly	20.3%	
		Less frequent	9.5%	
	42.4 Brush	Not used	20.3%	
		Before/after every feeding	35.1%	
		Daily	21.6%	
		Weekly	16.2%	
		Less frequent	6.8%	
	42.5 Disinfectant	Not used	45.9%	
		Before/after every feeding	13.5%	
		Daily	13.5%	
		Weekly	13.5%	
		Less frequent	13.5%	
43. Have blood samples been taken from the small heifer calves within the last six months to check the uptake of antibodies (total Ig)? (n=81)		Yes, due to calf health problems	16%	
		Yes, it is done routinely	1.2%	
		No	75.3%	
		Do not know	3.7%	
		I have never heard of antibody measurements	3.7%	

Section 4 – Quality of colostrum							
Question	Subquestions	Answers	Frequency	New question	New subquestions	Answers	Frequency
44. Is the colostrum's antibody content checked before being given to heifer calves? (n=81)		Yes, with a refractometer (Brix) *(go to 45)*	34.6%	How is the colostrum's antibody content checked before being given to heifer calves? (n=81) (Bielmann *et al.*, 2010)		With Brix (refractometer), with limit ≥22	18.5%
		Yes, with a colostrometer *(go to 46)*	8.6%			With Brix (refractometer), with limit ≤21	16.0%

		Yes, visually *(go to 46)*	16.0%			With colostrometer	8.6%
		No *(go to 47)*	40.7%			Visually	16.0%
45. What is the minimum limit used for the refractometer (Brix)? (n=28)		20 or lower	25%			Not checked	40.7%
		21	21.4%				
		22	39.3%				
		23	7.1%				
		24	3.6%				
		25	3.6%				
		26	0%				
		27 or higher	0%				
46. What is most often done with colostrum that does not meet the quality requirements? (n=48)		Only given to bull calves	27.1%	What is most often done with colostrum that does not meet the quality requirements? (n=81)		Used as colostrum	6.2%
						Only given to bull calves	16.0%
		Mixed with better colostrum	6.2%			Not used as colostrum	37.0%
		Used only AFTER initial colostrum feeding	10.4%			Not relevant (farmer does not check quality)	40.7%
		Not used as colostrum but as whole milk	41.7%				
		Discarded completely	10.4%				
		Other	4.2%				
47. Are cows/heifers vaccinated before calving with one of these vaccines? (n=81)		Yes, Lactovac Vet.	0%	Are cows/heifers vaccinated before calving? (n=81)		Yes	25.9%
		Yes, Rotavec®Corona Vet.	22.2%				
		Yes, another kind of vaccine	3.7%				
		No	70.4%			No	74.1%
		Do not know	3.7%				
48. How often is colostrum used for heifers from the following groups of cows? (n=81)	48.1 Cows treated with antibiotics (for example. penicillin, but not gold treatment)	Regularly	17.3%	How often is colostrum used for heifers from the following groups of cows? (n=81)	Cows treated with antibiotics (for example. penicillin, but not gold treatment)	It happens	48.1%
		Rarely	27.2%			It never happens	51.9%
		Never	51.9%				
		Do not know	3.7%				

	48.2 Cows with mastitis	Regularly	16.0%		Cows with mastitis	It happens	43.2%
		Rarely	24.7%			It never happens	56.8%
		Never	56.8%				
		Do not know	2.5%				
	48.3 Risk-cows (for example, paratuber-culosis, salmonella, mycoplasma)	Regularly	1.2%		Risk-cows (for example, paratuber-culosis, salmonella, mycoplasma)	It happens	6.1%
		Rarely	4.9%			It never happens	66.7%
		Never	66.7%				
		Do not know	27.2%			Do not know	27.2%
49. Is COLOSTRUM heat-treated/pasteurized before it is given to heifer calves? (n=81)		Yes, all colostrum *(go to 50)*	8.6%	Is COLOSTRUM heat-treated/pasteurized before it is given to heifer calves, if yes – how is it done? (n=81) Elizondo-Salazar and Heinrichs (2008) found that heat treating colostrum at 63 degrees or more lowered the concentration of IgG considerably.		No heat treatment	87.7%
		Yes, some colostrum *(go to 50)*	3.7%			Heat treated according to recommendations	4.9%
		Yes, colostrum from risk-cows *(go to 50)*	0%			Heat treated, but not according to recommendations	7.4%
		No *(go to section 5)*	87.7%				
50. How is the colostrum heat-treated? (n=10)		At 60-62 °C for 30-120 minutes	40%				
		At 63-65 °C for 30-60 minutes	40%				
		At 72 °C for 15 seconds	0%				
		Another method	10%				
		Do not know	10%				
51. Is the effect of heat treatment checked for the colostrum's content of bacteria (viable counts)? (n=10)		Yes	40%	*Not reduced or included in MCA*			
		No	50%				
		Do not know	10%				
52. How many hours at maximum is colostrum for heifer calves left without refrigeration/freezing after heat-treatment? (n=10)	52.1 Summer	It varies	30%				
		Less than 3 hours	70%				
		3-5 hours	0%				
		6-8 hours	0%				
		More than 8	0%				
	52.2 Winter	It varies	30%				
		Less than 3 hours	70%				
		3-5 hours	0%				
		6-8 hours	0%				
		More than 8	0%				

Section 5 – Milking and storage of colostrum							
Question	Subquestions	Answers	Frequency	New question	New subquestions	Answers	Frequency
53. How is the procedure before milking COLOSTRUM out for heifer calves? (n=81)	53.1 The udder is cleaned/dried off	Before every milking	92.6%	How is the procedure before milking COLOSTRUM out for heifer calves? (n=81)		Procedure with high hygiene (At least clean udder and wash hands with soap or wear gloves)	50.6%
		Regularly	1.2%				
		If dirty	1.2%				
		Rarely	1.2%				
		Never	3.7%				
	53.2 Rinse hands with water	Before every milking	21%				
		Regularly	12.3%				
		If dirty	29.6%			Procedure with low hygiene	49.4%
		Rarely	4.9%				
		Never	32.1%				
	53.3 The hands are washed with soap	Before every milking	9.9%				
		Regularly	9.9%				
		If dirty	14.8%				
		Rarely	16%				
		Never	49.4%				
	53.4 Disposable gloves are put on	Before every milking	49.4%				
		Regularly	6.2%				
		If dirty	6.2%				
		Rarely	9.9%				
		Never	28.4%				
54. How is the milking kit used for milking colostrum cleaned? (n=81)		Automatically (in milking equipment or robot) *(go to 55)*	77.8%	How is the milking kit used for milking colostrum cleaned? (n=81) (Böhm, 1998)		Automatically, between every cow or more frequent	42.0%
		Manually *(go to 56)*	22.2%				
55. How often is the milk kit cleaned? (n=63) *(go to 57)*		Small cleaning between each cow, 1-2 larger cleanings daily	36.5%			Automatically, after each milking or rarer	35.8%
		Before/after every cow	17.5%				
		Before/after every milking	38.1%			Manually with higher level of hygiene	6.2%
		Daily	6.3%				
		Weekly	0%				
		Less frequent	1.6%			Manually with lower level of hygiene	16.0%

56. How is the milking kit cleaned? (n=18)	56.1 Rinsed with warm water	Before/after every cow	33.3%			
		Before/after milking	33.3%			
		Daily	5.6%			
		Weekly	0%			
		Less frequent	5.6%			
		Not used	22.2%			
	56.2 Rinsed with cold water	Before/after every cow	16.7%			
		Before/after milking	22.2%			
		Daily	0%			
		Weekly	0%			
		Less frequent	5.6%			
		Not used	55.6%			
	56.3 Dipped in chlorine water	Before/after every cow	33.3%			
		Before/after milking	11.1%			
		Daily	5.6%			
		Weekly	5.6%			
		Less frequent	0%			
		Not used	44.4%			
57. How often are buckets/containers used for milking colostrum for heifer calves cleaned? (n=81)		Before/after every cow	11.1%	How often are buckets/containers used for milking colostrum for heifer calves cleaned? (n=81)	Often	75,3%
		Before/after milking	64.2%			
		Daily	19.8%		Rarely	24,7%
		Weekly	3.7%			
		Less frequent	1.2%			
58. What is used for cleaning of buckets/containers used for milking colostrum for heifer calves? (n=81)	58.1 Cold water	Not used	61.7%	How well are the buckets/containers used for milking colostrum for heifer calves cleaned? (n=81) (Böhm, 1998)	With a high level of hygiene	39.5%
		Before/after every cow	8.6%			
		Before/after milking	19.8%			
		Daily	6.2%			
		Weekly	0%			
		Less frequent	3.7%		With a medium level of hygiene	13.6%
	58.2 Hot water	Not used	1.2%			
		Before/after every cow	16.0%			
		Before/after milking	59.3%			
		Daily	17.3%			
		Weekly	4.9%		With a low level of hygiene	46.9%
		Less frequent	1.2%			

	58.3 Detergent	Not used	18.5%			
		Before/after every cow	11.1%			
		Before/after milking	33.3%			
		Daily	13.6%			
		Weekly	16.0%			
		Less frequent	7.4%			
	58.4 Brush	Not used	3.7%			
		Before/after every cow	12.3%			
		Before/after milking	34.6%			
		Daily	19.8%			
		Weekly	22.2%			
		Less frequent	7.4%			
	58.5 Disinfectant	Not used	43.2%			
		Before/after every cow	6.2%			
		Before/after milking	19.8%			
		Daily	9.9%			
		Weekly	11.1%			
		Less frequent	9.9%			
59. Is the colostrum stored in an open container for a period of time after milking (for example, in open buckets in the milking parlour, milking room or by the robot)? (n=81)		Yes	35.8%	Is the colostrum stored in an open container for a period of time after milking (for example, in open buckets in the milking parlour, milking room or by the robot)? (n=81)	Yes	59.3%
		Sometimes	23.5%			
		No	40.7%		No	40.7%
60. Is it possible that the colostrum could be left for more than 2 hours before feeding, refrigeration/freezing or pasteurization? (n=81)		Yes	16.0%	Is it possible that the colostrum could be left for more than 2 hours before feeding, refrigeration/freezing or pasteurization? (n=81)	Yes	48.1%
		Sometimes	32.1%			
		No	51.9%		No	51.9%
61. Is a colostrum bank used? (n=81)		No *(go to section 6)*	24.7%	Is a colostrum bank used? – if yes, is it done according to recommendations? (n=81) According to Børsting et al. (2009) colostrum should be cooled immediately after milking, in small portions, in disposable containers or in containers that are easy to clean. The colostrum should not be kept in a refrigerator for more than two days.	Yes, according to recommendations	34.6%
		Yes, refrigerator *(go to 62 – path 1)*	6.2%			
		Yes, freezer *(go to 63 – path 2)*	65.4%			
		Yes, refrigerator and freezer *(go to 64 – path 3)*	3.7%		Yes, but not according to recommendations	40.7%
62. Which of the following procedures are used in the colostrum bank? (multiple answers possible) (n=5)		Placed in refrigerator immediately after milking	40%			

(go to 66)	Refrigerated in small portions	20%			
	Disposable containers are used, for example, plastic bags	20%		No, colostrum bank is not used	24.7%
	The colostrum is labeled with the date and stored for a maximum of 1 week in the refrigerator	60%			
63. Which of the following procedures are used in the colostrum bank? (multiple answers possible) **(n=53)** *(go to 66)*	Placed in freezer immediately after milking	56.6%			
	Frozen in small portions	41.5%			
	Disposable containers are used, for example plastic bags	81.1%			
	Colostrum is fed immediately after thawing	56.6%			
64. Which of the following procedures are used when storing colostrum in a refrigerator? (multiple answers possible) **(n=3)**	Placed in refrigerator immediately after milking	66.7%			
	Refrigerated in small portions	33.3%			
	Disposable containers are used, for example, plastic bags	66.7%			
	The colostrum is labeled with the date and stored for a maximum of 1 week in the refrigerator	66.7%			
65. Which of the following procedures are used when storing colostrum in a freezer? (multiple answers possible) **(n=3)** *(go to 66)*	Placed in freezer immediately after milking	66.7%			
	Frozen in small portions	100%			

	Disposable containers are used, for example plastic bags	33.3%			
	Colostrum is fed immediately after thawing	33.3%			
66. Are the buckets/containers for storing colostrum thoroughly cleaned in between use? **(n=61)**	Yes, every time they are used	41.0%			
	Not every time, but on a regular basis	3.3%			
	When they are visibly dirty	0%			
	No	0%			
	Use Coloquick/disposable equipment/plastic bags	55.7%			

Section 6 – Whole milk and milk replacer

Question	Subquestion	Answers	Frequency	New question	New subquestion	Answers	Frequency
67. Are the heifer calves fed fully or partially with milk replacers? **(n=81)**		No, never *(go to 70)*	39.5%	Are the heifer calves fed fully or partially with milk replacers? (n=76)		No	35.5%
		Yes, at the beginning of the milk feeding period	2.5%			Yes	64.5%
		Yes, at the end of the milk feeding period	6.2%				
		Yes, throughout the whole milk feeding period	40.7%				
		Yes, it can happen	11.1%				
68. Is the milk replacer acidified? **(n=49)**		No, never	89.8%	Is whole milk and/or milk replacer ever acidified? (n=76)		Yes	15.8%
		Yes, at the beginning of the milk feeding period	0%				
		Yes, at the end of the milk feeding period	0%				

	Yes, throughout the whole milk feeding period	10.2%		No	84.2%
	Only when there are calf disease problems	0%			
71. Is whole milk acidified for the heifer calves with, for example, citric acid or formic acid? (n=54)	No, never	83.3%			
	Yes, at the beginning of the milk feeding period	3.7%			
	Yes, at the end of the milk feeding period	0%			
	Yes, throughout the whole milk feeding period	9.3%			
	Only when there are calf disease problems	3.7%			
72. Are lactic acid bacteria added to the whole milk for the heifer calves? (n=54)	No, never	83.3%	*Not reduced or included in MCA*		
	Yes, at the beginning of the milk feeding period	5.6%			
	Yes, at the end of the milk feeding period	0%			
	Yes, throughout the whole milk feeding period	11.1%			
	Only when there are calf disease problems	0			
69. Which temperature have you measured in the milk replacer when feeding it to the heifer calves? (n=49)	Below 37 °C	0%	Which temperature have you measured in the milk replacer and/or the whole milk when feeding it to the heifer calves? (n=76) Christiansen (2019) recommends 40-42 °C at feeding.	40-45 °C	64.5%
	37-39 °C	28.6%		Other temperature/ Not measured	35.5%
	40-45 °C	65.3%			
	Above 45 °C	2.0%			
	Not measured	4.1%			
81. Which temperature have you measured in the whole milk when feeding it to the heifer calves? (n=54)	Below 37 °C	1.9%			
	37-39 °C	29.6%			
	40-45 °C	59.3%			
	Above 45 °C	0%			
	Not measured	9.3%			

70. Are heifer calves fed fully or partially with whole milk (milk from the tank/milk of the same quality as delivered to the dairy)? (n=81)	No, never *(go to section 7)*	33.3%	Are heifer calves fed fully or partially with whole milk? If yes – Is the whole milk pasteurized, and how? (n=76) According to Anonymous (2017b, table page 10), pasteurization should be done at either 63 °C for a minimum of 30 minutes, or in a continuous flow system to 72 °C for 15 seconds.	Whole milk is never fed to the heifer calves	28.9%
	Yes, at the beginning of the milk feeding period	7.4%		Unpasteurized whole milk is fed to the heifer calves	46.1%
	Yes, at the end of the milk feeding period	1.2%			
	Yes, throughout the whole milk feeding period	45.7%		Whole milk pasteurized according to recommendations is fed to the heifer calves	17.1%
	Yes, it can happen	12.3%			
73. Is the whole milk pasteurized/heat-treated for the heifer calves in a pasteurization unit/milk taxi? (n=54)	No, never *(go to 78 – path 2)*	64.8%			
	Yes, at the beginning of the milk feeding period *(go to 74 – path 2)*	0%		Whole milk that is pasteurized, but not according to recommendations is fed to the heifer calves	7.9%
	Yes, at the end of the milk feeding period *(go to 74 – path 2)*	0%			
	Yes, throughout the whole milk feeding period *(go to 74 – path 2)*	31.5%			
	Only when there are calf disease problems *(go to 74 – path 2)*	1.9%			
74. How is the whole milk pasteurized for the heifer calves? (n=19)	60-62 °C for 30-120 minutes	26.3%			
	63-65 °C for 30-60 minutes	68.4%			
	72 °C for 15 seconds	0%			
	It varies	0%			
	Using another method	5.3%			

75. Is the effect of pasteurization checked on the whole milk's content of bacteria (viable counts)? (n=19)		Yes	15.8%	*Not reduced or included in MCA*
		No	84.2%	
		Do not know	0%	
76. How is whole milk stored after pasteurization? (n=19)		Cooled down to feeding temperature and given to the calves	84.2%	
		Cooled down to 5 °C and reheated before feeding	10.5%	
		Left without refrigeration and reheated before feeding	0%	
		Do not know	5.3%	
77. Is the pasteurized whole milk mixed with other non-pasteurized milk before it is given to the heifer calves? (n=19) *(go to 81)*		Yes	5.3%	
		Sometimes	15.8%	
		No	78.9%	
78. Is the whole milk given to the heifer calves within 2 hours after it has been milked from the cows? (If not pasteurized) (n=35)		Yes	45.7%	
		Sometimes	22.9%	
		No	31.4%	
79. Is the milk cooled to below 5°C and heated again? (if not fed within 2 hours) (n=19)		Yes	10.5%	
		Sometimes	0%	
		No	89.5%	
80. Is whole milk stored in an open container for a period of time before feeding (for example in a milk cart without a lid, in open buckets in the milking parlour, in the milking room or by the robot)? (n=35) *(go to 81)*		Yes	54.3%	
		Sometimes	2.9%	
		No	42.9%	
82. How often are the cows below milked into the tank, from which milk is used for feeding the heifer calves? (n=54)	82.1 Cows with elevated somatic cell counts	Daily	66.7%	
		Regularly	22.2%	
		Rarely	7.4%	
		Never	3.7%	
		Do not know	0%	
	82.1 Risk-cows (for example paratuberculos	Daily	1.9%	
		Regularly	0%	
		Rarely	7.4%	
		Never	53.7%	

	is, salmonella, mycoplasma)	Do not know	37.0%	

Section 7 – Waste milk for heifer calves							
Question	Subquestion	Answers	Frequency	**New Question**	New Subquestion	Answer	Frequency
83. Is waste-milk used for the heifer calves? (Waste-milk means all the milk that is not sent to the dairy) (n=81)		Yes *(go to 84)*	88.9%	Are heifer calves fed fully or partially with waste-milk? (Waste-milk means all the milk that is not sent to the dairy) If yes – Is the waste-milk pasteurized, and how? (n=81) According to Anonymous (2017b, table page 10), pasteurization should be done at either 63 °C for a minimum of 30 minutes, or in a continuous flow system to 72 °C for 15 seconds.		Yes, unpasteurized waste-milk	61.7%
		Occasionally *(go to 84)*	4.9%				
		No, never *(go to section 8)*	6.2%				
88. Is the waste milk for the heifer calves pasteurized/heat-treated in pasteurization units/milk taxi? (n=76)		No, never *(go to 94 – path 2)*	65.8%				
		Yes, at the beginning of the milk feeding period *(go to 89 – path 1)*	2.6%			Yes, waste-milk pasteurized according to recommendations	21.0%
		Yes, late in the milk feeding period *(go to 89 – path 1)*	1.3%				
		Yes, throughout the milk feeding period *(go to 89 – path 1)*	27.6%			Yes, but waste-milk is not pasteurized according to recommendations	11.1%
		Only when there are calf disease problems *(go to 89 – path 1)*	2.6%				
		Only if the cow is sick or suspected disease carrier *(go to 89 – path 1)*	0%				
89. How is waste milk for heifer calves pasteurized? (n=26)		60-62 °C for 30-120 minutes	30.8%			No. waste milk is never fed to the heifer calves	6.2%
		63-65 °C for 30-60 minutes	65.4%				
		72 °C for 15 seconds	0%				
		It varies	0%				
		Using another method	3.8%				

84. How often is milk from the cows below given to the heifer calves? (n=76)	84.1 Cows with elevated somatic cell counts	Daily	77.6%	Is milk from cows with elevated somatic cell counts fed to calves? (n=76)	Yes	97.4%
		Regularly	17.1%		No	2.6%
		Rarely	2.6%			
		Never	2.6%		Do not know	0%
		Do not know	0%			
	84.2 Cows with mastitis	Daily	30.3%	Is milk from cows with mastitis fed to calves? (n=76)	Yes	84.2%
		Regularly	38.2%		No	15.8%
		Rarely	15.8%			
		Never	15.8%		Do not know	0%
		Do not know	0%			
	84.3 Cows treated with antibiotics (for example penicillin, but not dry treatment)	Daily	28.9%	Is milk from cows treated with antibiotics fed to calves? (n=76)	Yes	81.6%
		Regularly	31.6%		No	18.4%
		Rarely	21.1%			
		Never	18.4%		Do not know	0%
		Do not know	0%			
	84.4 Risk-cows (for example paratuberculosis, salmonella, mycoplasma)	Daily	2.6%	Is milk from risk cows fed to calves? (n=76)	Yes	10.5%
		Regularly	1.3%		No	57.9%
		Rarely	6.6%			
		Never	57.9%		Do not know	31.6%
		Do not know	31.6%			
85. When are the heifer calves fed waste milk? (n=76)		At the beginning of the milk feeding period	3.9%	*Not reduced or included in MCA*		
		At the end of the milk feeding period	10.5%			
		Through the whole milk feeding period	82.9%			
		It varies	2.6%			
86. Is the waste milk for heifer calves acidified with, for example, citric or formic acid? (n=76)		No, never	84.2%	Is the waste milk for heifer calves ever acidified with, for example, citric or formic acid? (n=76)	Yes	15.8%
		Yes, at the beginning of the milk feeding period	2.6%			
		Yes, late in the milk feeding period	0%			
		Yes, throughout the milk feeding period	10.5%		No	84.2%
		Only when there are calf disease problems	2.6%			
		Only if the cow is sick or a suspected disease carrier	0%			

87. Is lactic acid bacteria added to the waste milk for heifer calves? (n=76)	No, never	88.2%	*Not reduced or included in MCA*
	Yes, at the beginning of the milk feeding period	2.6%	
	Yes, late in the milk feeding period.	0%	
	Yes, throughout the milk feeding period	9.2%	
	Only when there are calf disease problems	0%	
	Only if the cow is sick or a suspected disease carrier	0%	
90. Is the effect of the pasteurization checked on the waste milk's content of bacteria (viable counts)? (n=26)	Yes	19.2%	
	No	80.8%	
	Do not know	0%	
91. How is waste milk stored after pasteurization? (n=26)	Cooled down to feeding temperature and given to the calves	80.8%	
	Cooled down to 5°C and reheated before feeding	19.2%	
	Left without refrigeration and reheated before feeding	0%	
	Do not know	0%	
92. Is pasteurized waste milk stored in an open container for a period of time before feeding (for example in a milk taxi/cart without a lid)? (n=26)	Yes	15.4%	
	Sometimes	15.4%	
	No	69.2%	
93. Is pasteurized waste milk mixed with non-pasteurized milk before it is given to the heifer calves? (n=26) *(go to 97)*	Yes	3.8%	
	Sometimes	7.7%	
	No	88.5%	
94. Is waste milk always given to the heifer calves within 2 hours after it has been milked out? (n=50)	Yes *(go to 96)*	48.0%	
	No *(go to 95)*	52.0%	

95. Is waste milk cooled until it is below 5°C and then reheated? **(n=26)**		Yes	11.5%			
		Sometimes	0%			
		No	88.5%			
96. Is waste milk stored in an open container for a period of time before feeding (for example in a milk cart without a lid, an open buckets in the milking palour, the milking room or by robot)? **(n=24)**		Yes	50.0%			
		Sometimes	4.2%			
		No	45.8%			
97. How is the milking kit used for milking waste-milk cleaned? **(n=76)**		Automatically (in milking equipment or robot) *(go to 98)*	81.6%	How is the milking kit used for milking waste-milk cleaned? (n=76) (Böhm, 1998)	Automatically, between every cow or more frequent	46.1%
		Manually *(go to 99)*	18.4%			
98. How often is the milk kit cleaned? **(n=62)** *(go to 100)*		Small cleaning between each cow, 1-2 larger cleanings daily	45.2%		Automatically, after each milking or rarer	35.5%
		Before/after every cow	11.3%			
		Before/after every milking	37.1%		Manually with high level of hygiene	11.8%
		Daily	6.5%			
		Weekly	0%			
		Less frequent	0%		Manually with low level of hygiene	6.6%
99. How is the milking kit cleaned? **(Only answered by those that manually clean the kit)** **(n=14)**	99.1 Rinsed with warm water	Before/after every cow	0%			
		Before/after milking	85.7%			
		Daily	0%			
		Weekly	7.1%			
		Less frequent	0%			
		Not used	7.1%			
	99.2 Rinsed with cold water	Before/after every cow	7.1%			
		Before/after milking	42.9%			
		Daily	0%			
		Weekly	0%			
		Less frequent	7.1%			
		Not used	42.9%			
	99.3 Dipped in chlorine water	Before/after every cow	14.3%			

		Before/after milking	28.6%			
		Daily	0%			
		Weekly	7.1%			
		Less frequent	0%			
		Not used	50%			
100. What is used for cleaning buckets/containers used for milking waste milk? (n=76)	Cold water	Not used	55.3%	*Not reduced or included in MCA*		
		Before/after every use	28.9%			
		Daily	13.2%			
		Weekly	0%			
		Less frequent	2.6%			
	Hot water	Not used	0%			
		Before/after every use	56.6%			
		Daily	38.2%			
		Weekly	5.3%			
		Less frequent	0%			
	Detergent	Not used	11.8%			
		Before/after every use	30.2%			
		Daily	34.2%			
		Weekly	13.2%			
		Less frequent	10.5%			
	Brush	Not used	6.6%			
		Before/after every use	34.2%			
		Daily	34.2%			
		Weekly	15.8%			
		Less frequent	9.2%			
	Disinfectant	Not used	39.5%			
		Before/after every use	21.1%			
		Daily	17.1%			
		Weekly	10.5%			
		Less frequent	11.8%			
101. What temperature have you measured in the waste milk when feeding it to the heifer calves? (n=76)		Below 37 °C	1.3%	What temperature have you measured in the waste milk when feeding it to the heifer calves? (n=76) Christiansen (2019) recommends 40-42 °C at feeding.	40-45 °C	57.9%
		37-39 °C	30.3%		Other	42.1%
		40-45 °C	57.9%			
		Above 45 °C	2.6%			
		Do not know	7.9%			

Section 8 – Allocation of milk and feed for heifer calves (Not reduced or included in the MCA)			
Question	Subquestion	Answer	Frequency
102. How is milk most often brought to the heifer calf's bowl/teat bucket/trough/automatic milk feeder? (n=81)		In buckets or similar containers (*go to 103 – path 1)*	12.3%
		With milk taxi and bucket *(go to 104 – path 2)*	17.3%
		With milk taxi and metering pump *(go to 104 – path 2)*	42.0%
		With milk cart and bucket *(go to 104 – path 2)*	28.4%
103. What is used to clean the buckets in which milk is brought to calves? (n=10) *(go to 107)*	103.1 Cold water	Not used	50.0%
		Before/after every use	20.0%
		Daily	30.0%
		Weekly	0%
		Less frequent	0%
	103.2 Hot water	Not used	0%
		Before/after every use	80.0%
		Daily	20.0%
		Weekly	0%
		Less frequent	0%
	103.3 Detergent	Not used	40.0%
		Before/after every use	0%
		Daily	10.0%
		Weekly	40.0%
		Less frequent	10%
	103.4 Brush	Not used	0%
		Before/after every use	50.0%
		Daily	20.0%
		Weekly	30.0%
		Less frequent	0%
	103.5 Disinfectant	Not used	40.0%
		Before/after every use	10.0%
		Daily	0%
		Weekly	10.0%
		Less frequent	40.0%
104. How is the milk cart/milk taxi cleaned? (n=71)		Automatic washing program *(go to 105)*	31.0%
		Manually *(go to 106)*	69.0%
105. How often is the milk cart/milk taxi cleaned? (n=22) *(go to 107)*		Before/after every feeding	63.6%
		Daily	31.8%
		Weekly	4.5%
		Less frequent	0%
106. What is used for cleaning the milk cart/milk taxi? (n=49)	106.1 Cold water	Not used	53.1%
		Before/after every use	34.7%
		Daily	10.2%
		Weekly	0%
		Less frequent	2.0%

	106.2 Hot water	Not used	0%
		Before/after every use	69.4%
		Daily	22.4%
		Weekly	8.2%
		Less frequent	0%
	106.3 Detergent	Not used	12.2%
		Before/after every use	38.8%
		Daily	18.4%
		Weekly	22.4%
		Less frequent	8.2%
	106.4 Brush	Not used	6.1%
		Before/after every use	53.1%
		Daily	18.4%
		Weekly	20.4%
		Less frequent	2.0%
	106.5 Disinfectant	Not used	40.8%
		Before/after every use	12.2%
		Daily	6.1%
		Weekly	26.5%
		Less frequent	14.3%
107. How many liters of milk does the heifer calf get in a DAY under normal weather conditions? (n=81)	107.1 1st week of life	0L	0%
		1L	0%
		2L	4.9%
		3L	7.4%
		4L	8.6%
		5L	12.3%
		6L	34.6%
		7L	21.0%
		8L	9.9%
		9L	1.2%
		10L	0%
		11L	0%
		12L	0%
	107.2 2nd-4th week of life	0L	0%
		1L	0%
		2L	1.2%
		3L	6.2%
		4L	8.6%
		5L	6.2%
		6L	21.0%
		7L	18.5%
		8L	28.4%
		9L	3.7%

		10L	6.2%
		11L	0%
		12L	0%
	107.3 5th-8th week of life	0L	0%
		1L	0%
		2L	0%
		3L	3.7%
		4L	11.1%
		5L	6.2%
		6L	22.2%
		7L	12.3%
		8L	29.6%
		9L	6.2%
		10L	7.4%
		11L	1.2%
		12L	0%
	107.4 After 8 weeks	0L	17.3%
		1L	4.9%
		2L	6.2%
		3L	7.4%
		4L	16.0%
		5L	9.9%
		6L	11.1%
		7L	6.2%
		8L	16.0%
		9L	2.5%
		10L	2.5%
		11L	0%
		12L	0%
108. How many liters of milk does the heifer calf get in a DAY when it is cold (for example, in winter)? (n=81)	108.1 1st week of life	Never cold	2.5%
		0L	0%
		1L	0%
		2L	3.7%
		3L	7.4%
		4L	9.9%
		5L	12.3%
		6L	22.2%
		7L	22.2%
		8L	18.5%
		9L	1.2%
		10L	0%
		11L	0%
		12L	0%

	108.2 2nd-4th week of life	Never cold	2.5%
		0L	0%
		1L	0%
		2L	1.2%
		3L	4.9%
		4L	7.4%
		5L	11.1%
		6L	13.6%
		7L	17.3%
		8L	25.9%
		9L	8.6%
		10L	4.9%
		11L	2.5%
		12L	0%
	108.3 5th-8th week of life	Never cold	1.2%
		0L	0%
		1L	0%
		2L	1.2%
		3L	1.2%
		4L	11.1%
		5L	7.4%
		6L	19.8%
		7L	13.6%
		8L	23.5%
		9L	8.6%
		10L	7.4%
		11L	4.9%
		12L	0%
	108.4 After 8 weeks	Never cold	13.6%
		0L	8.6%
		1L	2.5%
		2L	3.7%
		3L	4.9%
		4L	17.3%
		5L	9.9%
		6L	11.1%
		7L	6.2%
		8L	16.0%
		9L	2.5%
		10L	2.5%
		11L	1.2%
		12L	0%
		Teat bucket	19.8%

109. What do the heifer calves drink from during the milk feeding period? (multiple answers possible)? (n=81)		Individual bowls/buckets	88.9%
		Common trough	66.7%
		Automatic calf feeder	2.5%
		From a nursing cow	0%
		Other	0%
110. What kind of feed is given to the heifer calves (other than milk) during the milk feeding period? (multiple answers possible) (n=81)	110.1 1st week of life	Calf starter	67.9%
		TMR	2.5%
		Hay/wrap	32.1%
		Other	8.6%
		No extra feed	22.2%
	110.2 2nd-4th week	Calf starter	82.7%
		TMR	19.8%
		Hay/wrap	49.4%
		Other	17.3%
		No extra feed	3.7%
	110.3 5th-8th	Calf starter	74.1%
		TMR	54.3%
		Hay/wrap	51.9%
		Other	24.7%
		No extra feed	0%
	110.4 After 8th week	Calf starter	63.0%
		TMR	72.8%
		Hay/wrap	45.7%
		Other	24.7%
		No extra feed	0%
111. At what age does milk-feeding of the heifer calves stop? (n=81)		Younger than 3 weeks	0%
		3-4 weeks	1.2%
		5-6 weeks	0%
		7-8 weeks	18.5%
		9-10 weeks	49.4%
		11-12 weeks	17.3%
		13-16 weeks	9.9%
		Older than 16 weeks	3.7%
112. What is the weaning procedure for heifer calves? (n=81)		Weaning over more than a week	29.6%
		Weaning over about a week	40.7%
		Weaning over 3-5 days	17.3%
		Weaning over 1-2 days	3.7%
		Stop from one feeding to the next	8.6%
113. How are the heifer calves housed at the beginning of the milk feeding period? (n=81)		Single housing *(go to section 9)*	88.9%
		Two calves together *(go to section 9)*	8.6%
		Group housing *(go to section 11)*	2.5%

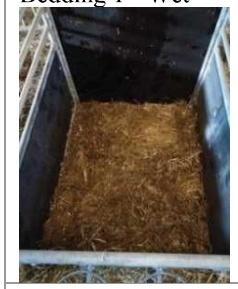
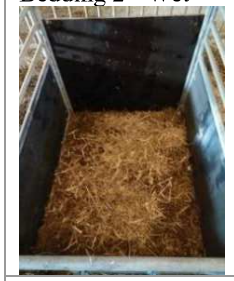
Section 9 – contact between calves, single housing (Two herds do not have single or dual housing, and are therefore excluded from this section)							
Question	Subquestion	Answers	Frequency	New question	New subquestion	Answers	Frequency
114. Where are the milk-fed heifer calves housed? (multiple answers possible) (n=79)		Outside (hutches, carts, pens etc.)	53.2%	Where are the milk-fed heifer calves housed? (n=79)		Inside	31.6%
		Outside, but protected (for example, below pent roof)	17.7%				
		Inside a large/open building with high ceilings (for example a barn)	45.6%			Outside	36.7%
		Inside a closed building (for example in an old tie stall)	22.8				
		Another form of housing	6.3%			Both inside and outside	31.6%
115. Which other animal groups do the milk-fed heifer calves have physical contact with? (multiple answers possible) (n=79)		None	78.5%	Do milk-fed heifer calves have physical contact to any other animal groups? (n=79)		No, none	78.5%
		Older heifer calves	19.0%				
		Replacement heifers	5.1%			Yes, some	21.5%
		Cows	6.3%				
		Bull calves	2.5%				
116. How is the contact between the heifer calves at the beginning of the milk feeding period? (n=79)		Each calf has contact with no more than one other calf	40.5%	How is the contact between the heifer calves at the beginning of the milk feeding period? (n=79)		Each calf has contact with no more than one other calf	40.5%
		Each/most calves have contact with two other calves	53.2%			Each/most calves have contact with more than one other calf	59.5%
		Each/most calves have contact with three or more calves	6.3%				
117. Can manure be spread directly from one pen/hutch/front yard of hutch to another (for example through bars)? (n=79)		Yes, it can happen	81.0%	Can manure be spread directly from one pen/hutch/front yard of hutch to another (for example through bars)? (n=79)		Yes, it can happen	81.0%
		No, it is not possible	19.0%			No, it is not possible	19.0%
118. How often is dirt and manure removed from corridor floors around the heifer calves' pens/hutches? (n=79)		Never	0%	How often is dirt and manure removed from corridor floors around the heifer calves' pens/hutches? (n=79)		Less than weekly	54.4%
		1-2 times per year	0%				
		When the entire section is emptied	11.4%			Weekly	24.1%

	When the calves are moved	19.0%			
	When cleaning	24.1%		Daily	21.5%
	Weekly	24.1%			
	Daily	21.5%			
119. How is a sick heifer calf handled in a single pen/two-calf pen? (multiple answers possible) (n=79)	The calf is isolated without physical contact with other calves	11.4%	How is a sick heifer calf handled in a single pen/two-calf pen? (n=79) (Callan and Garry, 2002)	The calf is handled with a lower risk of spreading infectious diseases	34.2%
	It is ensured that manure cannot be spread from the sick to the healthy calves	10.1%			
	The sick calf is fed/inspected after the other calves	57.0%		The calf is handled with a medium risk of spreading infectious diseases	49.4%
	Equipment used for sick calves is cleaned before being used for other calves	48.1%			
	None of the above are done	16.5%		The calf is handled with a higher risk of spreading infectious diseases	16.5%
120. How is the risk of disease transmission from sick calves handled in single/two-calf pens? (multiple answers possible) (n=79)	Disposable gloves are used when visiting sick calves	31.6%	How is the risk of disease transmission from sick calves handled in single/two-calf pens? (n=79) (Callan and Garry, 2002)	Handled with lower risk of transmission occurring	12.7%
	Hands are washed after handling sick calves	41.8%			
	Gloves are changed after contact with sick calves	16.5%		Handled with medium risk of transmission occurring	53.2%
	Boots are washed/changed after visiting sick calves	21.5%			
	Outerwear is changed after visiting sick calves	1.3%		Handled with higher risk of transmission occurring	34.2%
	None of the above are done	34.2%			

Section 10 – Cleaning among calves, single housing						
Question	Subquestion	Answers	Frequency	Question	Answer	Frequency
121. How are the heifer calves' hutches/pens cleaned? (If two calves are housed together, 'each calf' is considered to be the two calves housed together) (n=79)	121.1 Mucked out	More often than between each calf	8.9%	What level of hygiene are the heifer calves' hutches/pens kept with? (If two calves are housed together, 'each calf' is considered to be the two calves housed together) (n=79)	With a higher level of hygiene (Minimum muck out and dry out or wash with detergent and disinfectant between every calf)	68.4%
		Between each calf	84.8%			
		As needed	6.3%			
		Rarely	0%			
		Never	0%			
	121.2 Washing with high-pressure cleaner/brush	More often than between each calf	0%		With a lower level of hygiene	31.6%
		Between each calf	59.5%			
		As needed	12.7%			
		Rarely	16.5%			
		Never	11.4%			
	121.3 Washing with detergent	More often than between each calf	0%			
		Between each calf	25.3%			
		As needed	6.3%			
		Rarely	12.7%			
		Never	55.7%			
	121.4 Drying out	More often than between each calf	1.3%			
		Between each calf	63.3%			
		As needed	13.9%			
		Rarely	8.9			
		Never	12.7%			
	121.5 Disinfection (for example with lime, disinfectant, weed burner)	More often than between each calf	1.3%			
		Between each calf	53.2%			
		As needed	6.3			
		Rarely	7.6%			
		Never	31.6%			
122. How often are the following cleaning procedures done among the heifer calves? (n=79)	122.1 Rinsing of milk-feeding bowls/buckets	Before/after every feeding	48.1%	What level of hygiene are the heifer calves' bowls (milk, feed, water) kept with? (n=79) (Callan and Garry, 2002)	With a higher level of hygiene	27.8%
		Daily	26.6%			
		Weekly	8.9%			
		Between every calf	11.4%		With a lower level of hygiene	72.2%
		Rarely	5.1%			

	122.2 Milk-feeding bowls/buckets are thoroughly cleaned	Before/after every feeding	20.3%			
		Daily	15.2%			
		Weekly	19.0%			
		Between every calf	43.0%			
		Rarely	2.5%			
	122.3 Water bowls/water cups are cleaned	Before/after every feeding	24.1%			
		Daily	13.9%			
		Weekly	19.0%			
		Between every calf	38.0%			
		Rarely	5.1%			
	122.4 Feed bowls/troughs are emptied	Before/after every feeding	11.4%			
		Daily	31.6%			
		Weekly	38.0%			
		Between every calf	15.2%			
		Rarely	3.8%			
	122.5 Feed bowls/troughs are thoroughly cleaned	Before/after every feeding	2.5%			
		Daily	12.7%			
		Weekly	22.8%			
		Between every calf	50.6%			
		Rarely	11.4%			
124. If the calves have access to a dummy teat how often is this cleaned? (n=79)		There is no dummy teat	29.1%	If the calves have access to a dummy teat how often is this cleaned? (n=79)	Between calves	31.6%
		Is never cleaned	27.8%		When dirty	11.4%
		When the calf is moved from the hutch/pen	29.1%		Never	27.8%
		Several times during a milk feeding period	2.5%		The calves do not have access to a dummy teat	29.1%
		When it is dirty	11.4%			
		Weekly	0%			
		Daily	0%			
125. Have viable counts (bacterial counts) been made within the last six months to check the hygiene of milk-feeding bowls, milk carts, bottles etc.? (n=79)		Yes, due to calf health problems	7.6%	Have viable counts (bacterial counts) been made within the last six months to check the hygiene of milk-feeding bowls, milk carts, bottles etc.? (n=79)	Yes	8.9%
		Yes, it is done routinely	1.3%			
		No	82.3%		No	91.1%
		I have never heard of viable counts	5.1%			

	Do not know	3.8%			
126. Which of the following statements best describes how manure contamination in water or feed troughs is handled? (n=79)	Manure contamination is removed when there is time for it	7.6%	How is manure contamination in water and feed troughs handled? (n=79)	The troughs cleaned daily or never contaminated	91.1%
	Manure contamination is removed weekly	1.3%			
	Manure contamination is removed daily or more often	89.9%		The troughs are not cleaned daily	8.9%
	Manure contamination never occurs in either water or feed trough	1.3%			
127. Does it happen that birds sit in the calves' feed troughs/bowls? (n=79)	Yes, often	17.7%	Does it happen that birds sit in the calves' feed troughs/bowls? (n=79)	Yes	73.4%
	Yes, at special times of the year (for example during starling migration)	17.7%			
	Rarely	38.0%		No	26.6%
	No, never	26.6%			
128. How often is straw bedding scattered among the calves? (n=79)	Twice or more times per day	7.6%	How often is straw bedding scattered among the calves? (n=79)	Once daily or more	29.1%
	Once daily - several times when needed (for example calves with diarrhea)	21.5%			
	Once daily	29.1%		Only once daily	29.1%
	Every second day – more often when needed	34.2%			
	Every second day	6.3%		Less than once daily	41.8%
	Less frequently	1.3%			

129. Which of these images best illustrates the bedding in a calf pen/hutch just before scattering straw again? (n=79)	Bedding 1 - Wet 	1.3%	How is the bedding in a calf pen/hutch best characterized just before scattering straw again? (n=79)	Bedding wet	8.9%
	Bedding 2 - Wet 	7.6%			
	Bedding 3 - Moist 	65.8%		Bedding moist	65.8%
	Bedding 4 - Dry 	25.3%		Bedding dry	25.3%

130. Where is concentrate feed and roughage (apart from bedding) placed in the pen/hutch? (n=79)	130.1 Concentrate feed	Above height of the floor	38.0%	Where is concentrate feed placed in the pen/hutch? (n=79)	Inside pen	39.3%
		At the height of the floor	1.3%		Outside pen	58.2%
		No access	2.5%		No access	2.5%
		Outside the box/hutch	58.2%			
	130.2 Roughage	Above height of the floor	55.7%	Where is roughage (apart from bedding) placed in the pen/hutch? (n=79)	Inside pen	58.2%
		At the height of the floor	2.5%		Outside pen	19.0%
		No access	22.8%		No access	22.8%
		Outside the box/hutch	19.0%			
131. For how many weeks are the heifer calves housed on average in a single pen or with 2 calves together? (n=79)		Less than 2 weeks	10.1%	For how many weeks are the heifer calves housed on average in a single pen or with 2 calves together? (n=79)	<3 weeks	49.3%
		2-3 weeks	39.2%			
		4-5 weeks	34.2%		4-5 weeks	34.2%
		6-7 weeks	8.9%			
		8-9 weeks	6.3%		≥6 weeks	16.5%
		10-12 weeks	1.3%			
		More than 12 weeks	0%			
123. What is used for cleaning the following equipment among the heifer calves? (multiple answers possible) (n=79)	123.1 Milk-feeding bowls/bucket	Cold water	6.3%	*Not reduced or included in MCA*		
		Hot water	91.1%			
		Detergent	72.2%			
		Brush/machine	79.7%			
		Disinfection	24.1			
		No cleaning	0%			
	123.2 Water bowls	Cold water	11.4%			
		Hot water	83.5%			
		Detergent	62.0%			
		Brush/machine	73.4%			
		Disinfection	20.3%			
		No cleaning	0%			
	123.3 Feed bowls/trough	Cold water	6.3%			
		Hot water	82.3%			
		Detergent	53.2%			
		Brush/machine	72.2%			
		Disinfection	17.7%			
		No cleaning	7.6%			

132. What happens with the heifer calves after housing in this section ends? (n=79)	They are weaned here and moved into group housing on this property *(go to section 11)*	29.1%	
	They are moved to group housing on this property and weaned there *(go to section 11)*	64.6%	
	They are weaned here and then moved to other property/herd *(go to information about respondent)*	6.3%	
	They are moved to other property/herd where they are weaned *(go to information about respondent)*	0%	

Section 11 - Contact of group housed, milk-fed heifer calves (not reduced or included in the MCA)			
Question	**Subquestion**	**Answer**	**Frequency**
137. Where are the heifer calves in groups housed? (multiple answers possible) (n=76)		Outside (hutches, carts, pens etc.)	36.8%
		Outside, but protected (for example below pent roof)	13.2%
		Inside a large/open building with high ceilings (for example a barn)	53.9%
		Inside a closed building (for example an old tie stall)	18.4%
		On grass during the summer season	6.6%
		Another form of housing	3.9%
138. Which animal groups are housed in the same buildings/areas as the milk-fed heifer calves? (multiple answers possible) (n=76)		None	34.2%
		Older calves	57.9%
		Replacement heifers	17.1%
		Cows	17.1%
		Bull calves	2.6%
139. Is there physical contact between different groups of milk-fed heifer calves (for example through bars)? (n=76)		Yes	56.6%
		No	43.4%

140. Which other animal groups do the milk-fed heifer calves have physical contact with? (multiple answers possible) **(n=76)**	None	63.2%
	Older calves	32.9%
	Replacement heifers	2.6%
	Cows	3.9%
	Bull calves	0%
141. How large are the groups of milk-fed calves? (If there are different group sizes, then select the section with the most calves). **(n=76)**	4 or fewer calves	10.5%
	5-6 calves	42.1%
	7-8 calves	26.3%
	9-11 calves	14.5%
	12-15 calves	5.3%
	16-20 calves	1.3%
	21-25 calves	0%
	More than 25 calves	0%
142. Which of these images best illustrates the stocking density of the heifer calves at the end of the milk feeding period? **(n=76)**	 Less than 2 m2 for every calf	3.9%
	 Approx. 2 m2 for every calf	36.8%

		 More than 2 m2 for every calf	59.2%
143. Can all the calves in the group drink milk at the same time? (n=76)		Yes, there is plenty of room for that	57.2%
		Yes, there is exactly enough room for that	38.2
		Not for the whole period	0%
		Not relevant (automatic milk feeder)	3.9%
144. How are the groups of milk-fed heifers formed? (n=76)		Calves are moved in and removed as needed	10.5%
		Calves are moved in as needed until there is no more space and all removed simultaneously	11.8%
		Calves are moved in at the same time and removed as needed	21.1%
		Calves are moved in at the same time and taken out simultaneously (or if ill)	50.0%
		It varies	6.6%
145. How are runt calves handled (meaning calves that cannot keep up with calves of the same age)? (n=76)		They stay with the group, even when it is moved on	18.4%
		They are housed separately, in a group of runts	5.3%
		They are put together with younger calves	71.1%
		They are housed for themselves until they can join a new group	5.3%
146. Can manure be spread directly from one group pen to another (for example through bars)? (n=76)		Yes, there is a risk	71.1%
		No, it is not possible	28.9%
147. Do calves from different pens mix during cleaning or rearranging? (n=76)		No	38.2%
		Rarely	32.9%
		Yes	28.9%
148. How is it typically handled if one or more calves get sick in a group pen? (besides treatment) (n=76)	148.1 If few sick calves	They stay in the common pen	90.8%
		They are isolated individually	7.9%
		They are placed in common sick pens	1.3%
	148.2 If few calves with serious illnesses	They stay in the common pen	30.3%
		They are isolated individually	63.2%
		They are placed in common sick pens	6.6%

	148.3 If many sick calves	They stay in the common pen	76.3%
		They are isolated individually	6.6%
		They are placed in common sick pens	17.1%
149. How is the risk of disease transmission from sick calves handled in group pens? (multiple answers can be selected) (n=76)		It is ensured that manure cannot be spread from sick to healthy calves	6.6%
		Sick calves are fed/inspected after the other calves	35.5%
		Disposable gloves are used when visiting sick calves	22.4%
		Separate boots are used when visiting sick calves	0%
		Hands are washed after handling sick calves	28.9%
		Gloves are changed after contact with sick calves	13.2%
		Boots are washed after a visit to the sick pen	27.6%
		Outerwear is changed after a visit to the sick pen	2.6%
		Equipment used for sick calves is cleaned before being used for healthy calves	43.4%
		The whole group is considered to be ill	25.0%
		None of the above is done	26.3%

Section 12 - Cleaning among the calves – group housing, not reduced or analyzed by MCA			
Question	**Subquestion**	Answers	Frequency
150. How is cleaning of group pens with milk-fed heifer calves done? (n=76)	150.1 Mucked out	More often than between each group	15.8%
		Between each group	60.5%
		Less frequent	22.4%
		Never	1.3%
	150.2 Washing with high-pressure cleaner or bucket + brush	More often than between each group	1.3%
		Between each group	14.5%
		Less frequent	27.6%
		Never	56.6%
	150.3 Washing with detergent	More often than between each group	1.3%
		Between each group	5.3%
		Less frequent	19.7%
		Never	73.7%
	150.4 Drying out	More often than between each group	2.6%
		Between each group	34.2%
		Less frequent	19.7%
		Never	43.4%
	150.5 Disinfection with, for example lime, disinfectant or weed burner	More often than between each group	7.9%
		Between each group	36.8%
		Less frequent	9.2%
		Never	46.1%

151. How often are the following cleaning procedures done? (n=76)	151.1 Rinse milk funnel/teat bucket/sucking machine	Before/after every feeding	22.4%
		Daily	18.4%
		Weekly	15.8%
		Between every team	30.3%
		Less frequent	13.2%
	151.2 Thoroughly clean the milk trough/teat bucket/sucking machine	Before/after every feeding	7.9%
		Daily	9.2%
		Weekly	15.8%
		Between every team	51.3%
		Less frequent	15.8%
	151.3 Water bowls/water cups are thoroughly cleaned	Before/after every feeding	6.6%
		Daily	9.2%
		Weekly	30.3%
		Between every team	35.5%
		Less frequent	18.4%
	151.4 Feed trough is emptied	Before/after every feeding	9.2%
		Daily	51.3%
		Weekly	28.9%
		Between every team	7.9%
		Less frequent	2.6%
	151.5 Feed troughs are thoroughly cleaned	Before/after every feeding	2.6%
		Daily	9.2%
		Weekly	14.5
		Between every team	51.3%
		Less frequent	22.4%
152. Which of the following is used to thoroughly clean the equipment used with the calves in the group pens? (multiple answers possible) (n=76)	152.1 Milk trough/bucket/automatic milk feeder	Cold water	14.5%
		Hot water	60.5%
		Detergent	36.8%
		Brush/high-pressure cleaner	65.8%
		Disinfectant	7.9%
		No cleaning	9.2%
	152.2 Water bowls/water cups	Cold water	31.6%
		Hot water	42.1%
		Detergent	25.0%
		Brush/high-pressure cleaner	53.9%
		Disinfectant	5.3%
		No cleaning	9.2%
	152.3 Feeding trough	Cold water	17.1%
		Hot water	38.2%
		Detergent	21.1%
		Brush/high-pressure cleaner	59.2%
		Disinfectant	5.3%
		No cleaning	21.1%

153. If there is a dummy teat among the heifer calves, how often is it cleaned? (n=76)	There is no dummy teat	50.0%
	Is never cleaned	22.4%
	When the calves are moved from the hutch/pen	18.4%
	Several times during the milk feeding period	1.3%
	When it/they is/are dirty	7.9%
	Weekly	0%
	Daily	0%
154. Which of the following statements best describes how manure contamination in water or feed troughs is handled? (n=76)	Manure contamination is removed when there is time for it	0%
	Manure contamination is removed weekly	13.2%
	Manure contamination is removed daily or more often	82.9%
	Manure contamination never occurs in either water or feed trough	1.3%
155. Does it happen that birds sit in the heifer calves' feeding trough? (n=76)	Yes, often	18.4%
	Yes, at special times of the year (for example during starling migration)	15.8%
	Yes, rarely	38.4%
	No, never	27.6%
156. Does it happen that cats defecate in the calves' bedding, feeding trough or feeding table? (n=76)	Yes	18.4%
	Rarely	32.9%
	No	34.2%
	Do not know	14.5%
157. Does it happen that a dog defecates in the calves' bedding, feeding trough or feeding table? (n=76)	Yes	3.9%
	Rarely	26.3%
	No	64.5%
	Do not know	5.3%
158. How often is bedding scattered among the group housed, milk-fed calves? (n=76)	Several times daily	2.6%
	Once daily - several times if needed	18.4%
	Once daily	31.6%
	Every other day - more often if needed	25.0%
	Every other day	13.2%
	Rarer	9.2%
159. Which of these images best illustrates the bedding in a group pen just before scattering again? (n=76)	 Bedding A	0%

		 Bedding B	17.1%
		 Bedding C	72.4%
		 Bedding D	10.5%
160. Where is concentrate feed and roughage (apart from bedding) placed in the pen/hutch? (n=76)	160.1 Concentrate feed	Above floor level	44.7%
		At floor level	5.3%
		No access	0%
		Outside the pen/hutch	50%
	160.2 Roughage	Above floor level	50%
		At floor level	5.3%
		No access	19.7%
		Outside the pen/hutch	25.0%
161. How often is dirt and manure removed from corridor floors around the group pens? (n=76)		Never	1.3%
		1-4 times a year	1.3%
		When the entire section is emptied	21.1%
		When the calves are moved	13.2%
		Weekly	27.6%
		Daily	35.5%

162. Are bull calves kept in the herd? (n=81)	Yes, until they are moved to a veal calf herds or exported	95.1%
	Yes, until they are moved to another herd	2.5%
	Yes, they are kept until slaughter	0%
	No, they are euthanized	2.5%

Section 13 - Bull calves, not reduced or included in the MCA

Question	Subquestion	Answers	Frequency
166. Do the bull calves receive colostrum? (n=79)		Yes *(go to 167)*	97.5%
		No *(go to 170)*	2.5%
167. How soon after birth do bulls calves get their first colostrum? (n=77)		Within 2 hours	10.4%
		Within 4 hours	28.6%
		Within 6 hours	45.5%
		More than 6 hours	15.6%
168. How many liters of colostrum do bull calves get at first feeding? (n=77)	168.1 Large dairy breed (for example Holstein)	Not relevant	0%
		0L	0%
		½L	0%
		1L	0%
		1½L	0%
		2L	1.3%
		2½L	7.8%
		3L	23.4%
		3½L	9.1%
		4L	51.9%
		It varies	6.5%
	168.2 Small dairy breeds (Jersey)	Not relevant	80.5%
		0L	0%
		½L	0%
		1L	0%
		1½L	0%
		2L	1.3%
		2½L	2.6%
		3L	7.8%
		3½L	1.3%
		4L	6.5%
		It varies	0%
	168.3 Mixed-breed calves	Not relevant	22.1%
		0L	0%
		½L	0%
		1L	0%
		1½L	0%
		2L	2.6%

		2½L	2.6%
		3L	18.2%
		3½L	7.8%
		4L	39.0%
		It varies	7.8%
169. What quality of colostrum is most often given to the bull calves (hygiene and antibody content)? (n=77)		Same quality as the heifer calves get	88.3%
		Stored in the colostrum bank for too long	0%
		Too poor quality for the heifers	11.7%
		Second or later milking of colostrum	0%
		Other	0%
170. Where are the milk-fed bull calves housed? (multiple answers possible) (n=79)		Outside (hutches, carts, pens etc.)	54.4%
		Inside a large/open building with only neonatal and small calves	7.6%
		Inside a large/open building with several age groups in the same stable	27.8%
		Inside an enclosed building and only with neonatal and small calves	15.2%
		Inside a closed building and with several age groups in the same stable	17.7%
		Another form of housing	1.3%
171. How many other calves does each bull calf have contact with? (n=79)		Each bull calf has contact with no more than one other calf	32.9%
		Each/most bull calves have contact with two other calves	55.7%
		Each/most bull calves have contact with three or more calves	11.4%
172. Can manure be spread directly from one bull pen/hutch to another (for example through bars)? (n=79)		Yes, it can happen	81.0%
		No, it is not possible	19.0%
173. What other animal groups do the milk-fed bull calves have physical contact with? (multiple answers possible) (n=79)		None	32.9%
		Milk-fed heifer calves	65.8%
		Older calves	11.4%
		Replacement heifers	0%
		Cows	2.5%
		Other bull calves	10.1%
174. How often are the following procedures used to prevent the spread of disease between bulls and heifers? (n=79)	174.1 Changing or washing of boots	Never	74.7%
		Rarely	7.6%
		Often	11.4%
		Always	6.3%

	174.2 Changing of outerwear	Never	84.8%
		Rarely	10.1%
		Often	1.3%
		Always	3.8%
	174.3 Changing of manure-soiled clothing	Never	67.1%
		Rarely	13.9%
		Often	12.7%
		Always	6.3%
	174.4 Washing or shaking of hands	Never	62.0%
		Rarely	16.5%
		Often	12.7%
		Always	8.9%
	174.5 Use of clean disposable gloves	Never	65.8%
		Rarely	5.1%
		Often	15.2%
		Always	13.9%
175. How often is bedding scattered among the bull calves? (n=79)		2 or more times daily	8.9%
		Once daily - several times as needed (for example, calf with diarrhea	22.8%
		Once daily	29.1%
		Every other day - more often when needed	0%
		Every other day	12.7%
		Less frequently	2.5%
176. How are the bulls' hutches/pens cleaned? (If two calves are housed together, 'each calf' is considered to be the two calves housed together) (n=79)	176.1 Mucked out	More often than between each calf	7.6%
		Between each calf	82.3%
		As needed	10.1%
		Rarely	0%
		Never	0%
	176.2 Washing with high-pressure cleaner or brush	More often than between each calf	0%
		Between each calf	53.2%
		As needed	15.2%
		Rarely	13.9%
		Never	17.7%
	176.3 Washing with detergent	More often than between each calf	0%
		Between each calf	24.1%
		As needed	8.9%
		Rarely	10.1%
		Never	57.0%

	176.4 Drying out	More often than between each calf	0%
		Between each calf	57.0%
		As needed	6.3%
		Rarely	10.1%
		Never	26.6%
	176.5 Disinfection (for example with lime, disinfectant, weed burner)	More often than between each calf	1.3%
		Between each calf	41.8%
		As needed	12.7%
		Rarely	7.6%
		Never	36.7%
177. How long do the bull calves most often stay in the herd? (n=79)		2-4 weeks	63.3%
		5-8 weeks	35.4%
		9-12 weeks	1.3%
		more than 12 weeks	0%
178. How are bull calves picked up when they are sold/moved (n=79)		Buyer of the calves/hauler picks up the calves and his truck is driven into the stable or calf section *(go to 179)*	19.0%
		Buyer of the calves/hauler drives up to the herd and picks up the calves himself in the stable/section *(go to 179)*	38.0%
		The calves are placed in delivery sections inside the property and collected from there *(go to 179)*	25.3%
		The calves are placed in the delivery section/cart away from the property and picked up there *(go to 180)*	17.7%
		Not relevant: The bull calves stay on the property until slaughter *(go to 180)*	0%
179. Does the following occur when collecting the bull calves? (n=65)	179.1 Calf pickup person changes/washes boots before entry	Do not know	23.1%
		Every time	16.9%
		Often	9.2%
		Rarely	12.3%
		Never	38.5%
	179.2 Calf pickup person comes in contact with animals other than the calves who are being picked up	Do not know	3.1%
		Every time	3.1%
		Often	6.2%
		Rarely	26.2%
		Never	61.5%
180. How are rejected calves handled? (n=79)		They are never put together with other calves	6.3%
		They are housed together with other rejected calves	7.6%
		They are put together with younger calves	16.5%
		Calves are never rejected	69.6%

Information about the respondent – not reduced			
134+163+181. Are you the one who answered the whole questionnaire? (n=81)		Yes, I have filled it all out myself	86.4%
		Yes, but I have discussed some of the answers with others along the way	13.6%
		No, we have changed respondent along the way	0%
135+164+182. What is your role in the farm? (n=81) *Included as supplementary variable in the MCAs*		Owner involved in the running of the farm	67.9%
		Owner not involved in the running of the farm	0%
		Spouse helping with the running of the farm	3.7%
		Operations manager with overview of the entire operation	18.5%
		Employee with responsibilities/tasks throughout the company	9.9%
		Employee with responsibilities/tasks among the cows	0%
		Employee with responsibilities/tasks among calves/young stock	3.7%
		Trainee with responsibilities/tasks throughout the farm operations	0%
		Trainee with responsibilities/tasks among calves/young animals	0%
		Cattle herd management consultant	0%
		Herd health consulting veterinarian	0%
		Student/researcher/lecturer	0%
		Other	0%
136+165+183. On a scale of 0-10, how likely do you think it is that infections spread between calves in the herd in the following ways? (n=81)	-1. During or just after the birth	0 (does not happen)	1.2%
		1	1.2%
		2	9.9%
		3	6.2%
		4	4.9%
		5	11,1%
		6	8.6%
		7	13.6%
		8	18.5%
		9	7.4%
		10 (definitely happens)	17.3%
	-2. Via the calf caretaker or other staff	0 (does not happen)	1.2%
		1	1.2%
		2	7.4%
		3	6.2%
		4	8.6%
		5	17.3%
		6	12.3%
		7	18.5%
		8	11.1%

		9	4.9%
		10 (definitely happens)	11.1%
	-3. Via tools or equipment	0 (does not happen)	0%
		1	6.2%
		2	16.0%
		3	11.1%
		4	13.6%
		5	22.2%
		6	9.9%
		7	2.5%
		8	7.4%
		9	3.7%
		10 (definitely happens)	7.4%
	-4. During high-pressure cleaning or other washing of inventory	0 (does not happen)	21.0%
		1	19.8%
		2	9.9%
		3	3.7%
		4	3.7%
		5	17.3%
		6	6.2%
		7	6.2%
		8	8.6%
		9	0%
		10 (definitely happens)	3.7%

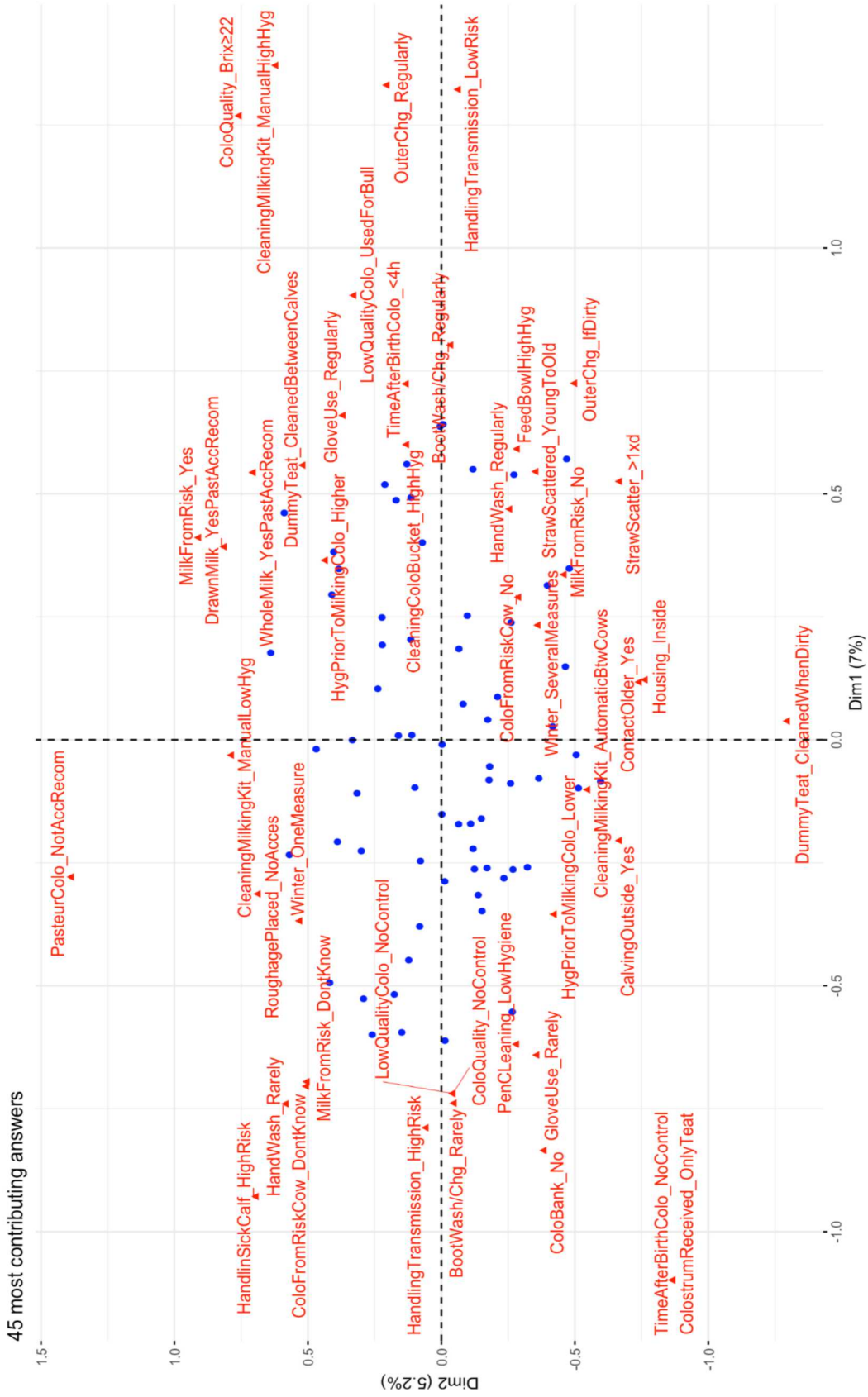
Appendix 2

Demographics of the 69 herds included in the MCA

	n	Mean	Min	Max
Number of animals in the herd	69	576	199	2000
Number of cows in the herd	69	323	100	989
Number of heifers (>6 months)	69	169	8	1000
Number of calves (<6 months)	69	87	21	271
		Median	**Min**	**Max**
Number of animals bought **(35 herds have not bought animals within the last year)**	34	78	1	416
Number of herds bought from	34	1	1	11
Number of properties	69	2	1	5
		Small (<150 cows)	Medium (150-300 cows)	Large (>300 cows)
Herd Size	69	11	27	31

Role of respondent (n=69)	**n**	**Frequency**
Owner involved in the running of the farm	44	63.8%
Spouse helping with the running of the farm	2	2.9%
Operations manager with overview of the entire operation	13	18.8%
Employee with responsibilities/tasks throughout the company	7	10.1%
Employee with responsibilities/tasks among calves/ youngstock	3	4.3%

Appendix 3


45 most contributing answers
PasteurColo_NotAccRecom
HandlinSickCalf_HighRisk
HandWash_Rarely
ColoFromRiskCow_DontKnow
MilkFromRisk_DontKnow
HandlingTransmission_HighRisk
LowQualityColo_NoControl
BootWash/Chg_Rarely
ColoQuality_NoControl
PenCLeaning_LowHygiene
ColoBank_No
GloveUse_Rarely
HygPriorToMilkingColo_Lower
CalvingOutside_Yes
TimeAfterBirthColo_NoControl
ColostrumReceived_OnlyTeat
CleaningMilkingKit_ManualLowHygi
RoughagePlaced_NoAcces
Winter_OneMeasure
MilkFromRisk_Yes
DrawnMilk_YesPastAccRecom
WholeMilk_YesPastAccRecom
DummyTeat_CleanedBetweenCalves
HygPriorToMilkingColo_Higher
GloveUse_Regularly
CleaningColoBucket_HighHyg
ColoFromRiskCow_No
Winter_SeveralMeasures
CleaningMilkingKit_AutomaticBtwCows
ContactOlder_Yes
Housing_Inside
DummyTeat_CleanedWhenDirty
LowQualityColo_UsedForBull
TimeAfterBirthColo_<4h
BootWash/Chg_Regularly
HandWash_Regularly
StrawScattered_YoungToOld
MilkFromRisk_No
StrawScatter_>1xd
ColoQuality_Brix≥22
CleaningMilkingKit_ManualHighHyg
OuterChg_Regularly
HandlingTransmission_LowRisk
FeedBowlHighHyg
OuterChg_IfDirty
Dim2 (5.2%)
Dim1 (7%)
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.0
-0.5
0.0
0.5
1.0

Abbreviation in biplot	Meaning
BootWash/Chg_Rarely	Boots are rarely changed or washed before handling heifer calves.
BootWash/Chg_Regularly	Boots are often changed or washed before handling heifer calves.
CalvingOutside_Yes	Some or all of the calves are born outside
CleaningColoBucket_HighHyg	Cleaning of the bucket used for colostrum is done with a high level of hygiene.
CleaningMilkingKit_AutomaticBtwCows	The milking kit used to milk colostrum is cleaned automatically between cows.
CleaningMilkingKit_ManualHighHyg	The milking kit used to milk colostrum is cleaned manually with a high level of hygiene.
CleaningMilkingKit_ManualLowHyg	The milking kit used to milk colostrum is cleaned manually with a low level of hygiene.
ColoBank_No	Does not use a colostrum bank.
ColoFromRiskCow_DontKnow	Do not know if calves receive colostrum from risk cows.
ColoFromRiskCow_No	Calves never receive colostrum from a risk cow.
ColoQuality_Brix ≥22	Colostrum quality is checked with brix, the minimum value used is ≥22%
ColoQuality_NoControl	The farmer does not check the quality of the colostrum.
ColoReceived_OnlyTeat	The calves only receive colostrum by suckling the dam.
ContactOlder_Yes	The calves have physical contact with older animals.
DrawnMilk_YesPastAccRecom	Waste milk is used for calves, and is pasteurized according to recommendations.
DummyTeat_CleanedBetweenCalves	The dummy teat is cleaned between calves.
DummyTeat_CleanedWhenDirty	The dummy teat is cleaned when it is dirty.
FeedBowlHighHyg	The heifer calves feed bowls are kept clean.
GloveUse_Rarely	Disposable gloves are rarely used before handling heifer calves.
GloveUse_Regularly	Disposable gloves are regularly used before handling heifer calves.
HandlingTransmission_HighRisk	The risk of transmission from a sick calf is handled with a higher risk of transmitting disease
HandlingTransmission_LowRisk	The risk of transmission from a sick calf is handled with a lower risk of transmitting disease
HandlinSickCalf_HighRisk	When handling sick heifer calves, it is done with a higher risk of spreading infectious diseases.
HandWash_Rarely	Hands are rarely washed before handling heifer calves.
HandWash_Regularly	Hands are regularly washed before handling heifer calves.
Housing_Inside	The calves are housed inside
HygPriorToMilkinColo_Higher	The procedures used before milking colostrum are of higher hygiene
HygPriorToMilkingColo_Lower	The procedures used before milking colostrum are of lower hygiene

LowQualityColo_NoControl	The farmer does not check the quality of the colostrum.
LowQualityColo_UsedForBull	Colostrum with a low quality is used for bull calves.
MilkFromRisk_DontKnow	Do not know if milk from risk cows is fed to calves
MilkFromRisk_No	The calves never receive milk from risk cows.
MilkFromRisk_Yes	Calves receive milk from risk cows
OuterChg_IfDirty	Outer layer is changed if it is dirty before handling heifer calves.
OuterChg_Regularly	Outer layer is regularly changed before handling heifer calves.
PasteurColo_NotAccRecom	Colostrum is pasteurized, but not according to recommendations.
PenCLeaning_LowHygiene	The single housing pens are cleaned with a low level of hygiene.
RoughagePlaced_NoAcces	The calves do not have access to roughage
StrawScatter_>1xday	Straw is scattered more than once daily.
StrawScattered_YoungToOld	Straw is scattered in the order young to old calves.
TimeAfterBirthColo_<4h	The calves receive colostrum within 4 hours after calving.
TimeAfterBirthColo_NoControl	The calves only get colostrum by teat, and therefore there is no control with the time after birth before receiving colostrum.
WholeMilk_YesPastAccRecom	Whole milk is used for calves, and is pasteurized according to recommendations.
Winter_OneMeasure	The farmer uses one aid to keep the calves warm and dry when its cold.
Winter_SeveralMeasures	More than one aid is used to keep the calves warm and dry when it is cold.